
CHULA VISTA CO₂ REDUCTION PLAN

Adopted November 14, 2000



CO₂ REDUCTION TASK FORCE

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ABBREVIATIONS USED THROUGHOUT DOCUMENT

APCD	Air Pollution Control District
Btu	British thermal unit
CEC	California Energy Commission
CH ₄	Methane
CO ₂	Carbon dioxide
CPUC	California Public Utility Commission
EPA	U.S. Environmental Protection Agency
FCCC	Framework Convention Climate Change
ICLEI	International Council for Local Environmental Initiatives
IPCC	Intergovernmental Panel on Climate Change
KWh	Kilowatt-hour
Lbs	Pounds
MM	Million
MMBtu	Million Btu
mpg	Miles per gallon
MW	Megawatt
MWh	Megawatt-hour
SANDAG	San Diego Association of Governments
SDG&E	San Diego Gas & Electric
VMT	Vehicle miles traveled

CARBON-CARBON DIOXIDE CONVERSION

Because the primary audience of this plan is non-technical, global warming emissions are expressed in pounds or tons of carbon dioxide (CO₂) rather than carbon (C). The conversion is 44 pounds of CO₂ for 12 pounds of C, or 3.666667 pounds of CO₂ per one pound of C.

EXECUTIVE SUMMARY

The Problem

The world's population is burning carbon-based fossil fuels faster than the earth's natural systems can absorb the resulting uncombusted CO₂ gas. Increased CO₂ emissions are being trapped in the atmospheric "greenhouse" that keeps the planet warm, raising concern about elevated temperatures and global warming. Although the scientific evidence of global warming is still inconclusive, there is broad international agreement that reducing CO₂ emissions is a sensible precaution until more is known about the greenhouse effect.

What is Chula Vista's Contribution?

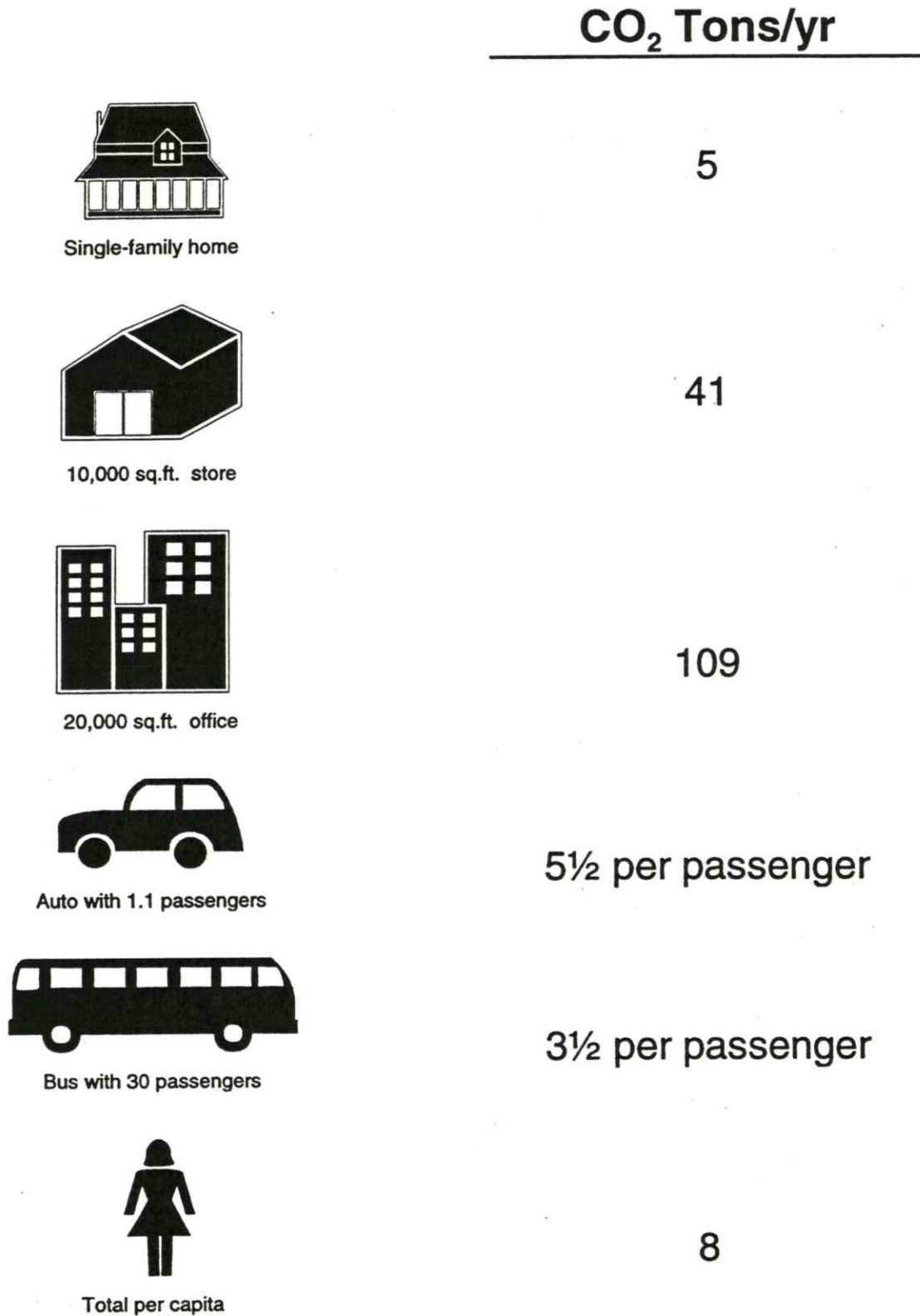
Each person's share of Chula Vista's CO₂ emissions is about eight tons per capita every year. About half of this comes from automobile driving and gasoline; another quarter comes from energy use in homes, much of that in electricity; and the remainder comes from energy use in stores, offices, industries, and municipal government. This adds up to a total of about one million tons of emissions annually, or about eight tons per person as shown in Figure ES-1.

What Can One City Do?

One city alone cannot resolve the issue of climate change. However, cities are now recognized internationally for their role in contributing to, and conversely, their potential to reduce carbon dioxide emissions by addressing how cities are built, what materials are used in building our cities, where cities place roads, and how local decisions effect the way citizens live, where they work, how they play and the interaction between these elements.

Half of the world's population will live in urban areas by the year 2000. Further, such areas are major centers of carbon dioxide emissions. Local energy use varies significantly - stemming from differences in urban form, land use, transportation, and utilization of energy, all of which are matters that cities exercise decisions over.

Figure ES-1
EXAMPLES OF CHULA VISTA CO₂ EMISSIONS
(1990)



Chula Vista's International Link

In 1992, Chula Vista was asked to participate with a select group of cities throughout the world in a model program aimed at developing municipal action plans for the reduction of greenhouse gases. This project recognizes that municipalities are the level of government closest to the people, and that the success of global action depends on the support of people at the community level everywhere. Municipal participation fulfills one part of the International Framework Convention on Climate Change, signed by over 159 countries, including the United States. The International Framework on Climate Change is an international agreement to achieve carbon dioxide reduction through global cooperation and collective decision making. Municipalities have been incorporated into this process because of the recognition that all local planning and development have direct consequence to energy consumption, and these decisions, at their source, are made at a local level.

Cities are important partners in climate protection because they exercise key powers over urban infrastructure, including neighborhood design; transportation infrastructure such as roads, streets, pedestrian areas, bicycle lanes and public transport; waste management; parks, local building and facilities. These items all relate directly to the contribution of greenhouse emissions and correlated energy use.

This project was sponsored by the International Council of Local Environmental Initiatives (ICLEI) and the United Nations Environment Programme. ICLEI is an international association of local authorities with over 180 members worldwide. ICLEI's purpose is to improve the capacity of local authorities to prevent environmental problems, to respond effectively to problems when they arise, and to enhance their natural and built environments at the local level.

Other local agencies in the program include: Dade County, Florida; Portland, Oregon; Minneapolis/Saint Paul, Minnesota; Toronto, Canada; Denver, Colorado; Bologna, Italy, Copenhagen, Denmark; Ankara, Turkey; Saarbrücken, Germany; Hannover, Germany; Helsinki, Finland. Each city in the program was asked to develop a local action plan, to be reviewed and approved by the respective legislative body of that municipality. Each participant was to create local policy measures which have multiple benefits to the city involved and at the same time identify a carbon reduction goal through the implementation of those measures. The carbon dioxide reduction goal was to fit within the realm of international climate treaty reduction targets. Each policy measure has multiple benefits to the city, none stand alone. In other words, even without the benefits of carbon dioxide reduction, these policies reduce energy consumption and aim toward a more pedestrian friendly and integrated city.

The local action plans are being used as models for cities across the country. Chula Vista, once again, is at the forefront of future planning. Although greenhouse gases are not regulated as a pollutant under the Clean Air Act at this time, federal governments are required to meet CO₂ reduction targets; thus it may be in the future. The local action plans provide a bottom-up approach to a complex and vexing problem. As the international climate and science community come closer to a consensus on climate change, as is evolving slowly through the United Nations International Climate Panel, federal governments will turn their attention toward cities.

How Much Worse Could it Get?

If no municipal action is taken, CO₂ emissions are projected to increase as much as 25% by 2010. This increase is being driven by an expected 23% growth in population, and more notably for CO₂, by a projected 44% increase in vehicles miles traveled (VMT). Figure 1.6 in (Sec. 1, pg. 25) illustrates a range of emission forecasts which, in the worst case, project 2010 emissions as high as 1.5 million tons/yr. At this rate, each person's share of emissions could reach 10 tons every year.

What Can be Done?

Chula Vista can lower its CO₂ emissions by diversifying its transportation system and using energy more efficiently in all sectors. These strategies not only save energy and CO₂, but they also increase personal and business savings, and create jobs. To focus City efforts in this direction, it is proposed that Chula Vista adopt the international CO₂ reduction goal of returning to pre-1990 levels by 2010. In order to achieve this goal, the plan proposes a reduction strategy composed of the following eight elements:

1. To spur action, increase the public's awareness of the problem. Focus in particular on the next generation of Chula Vistans through continuous implementation of the Global Warming Teachers kit and guide, developed by the City, and coordinate with the Chula Vista Elementary School District to make CO₂ reduction an everyday practice by 2010.
2. Reduce the long-term need for travel in the community through efficient land-use/transportation coordination and telecommunications technology. Focus in particular on shaping areas east of Interstate 805 to be as CO₂ friendly as possible.
3. Of the travel that does occur, provide for multi-modal choices.

4. Of the automobile driving that remains, work to make it as clean as possible.
5. Capture cost-effective building efficiency improvements in both new construction and remodeling through a mix of implementation approaches.
6. Lead the effort with municipal energy programs that can be showcased. Focus on encouraging personal and organizational (business, government, school districts, residential) actions.
7. Interlock the City's efforts with other regional programs in order to strengthen region-wide progress on climate protection (Air Pollution Control District, SANDAG programs). Examples include: the Telecenter effort, BECA, etc.
8. Focus initially on a few short-range actions to build visibility and results, and then periodically update and fine tune the strategy over time.

This strategy is to be implemented primarily through voluntary efforts with encouragement from a strong public information and advocacy effort. Specifically, 20 action measures are recommended for initial implementation as summarized in Table ES-1, and explained in detail in Chapter 7. These action measures are intended to promote clean fuel vehicles; alternatives to driving; transportation-efficient land-use planning; and energy efficient building construction. Several of the action measures are to be implemented by municipal government to demonstrate leadership in CO₂ reduction, and thereby encourage personal and organizational action throughout the community.

When fully implemented in 2021, the action measures will save approximately 100,000 tons/yr of CO₂ emissions, which is roughly one quarter of the savings needed to achieve the international reduction goal. The international goal is to reduce CO₂ emissions 20% below 1990 levels by 2010. Implementing the 20 action measures will require roughly \$25 million in capital costs and about \$5 million/yr in operation and maintenance costs over the next 14 years (all costs are expressed in 1995 dollars). The capital and O&M costs represent a total outlay of roughly \$95 million, which will be shared by municipal government, businesses, homeowners, and other regional agencies. This outlay, however, is estimated to produce approximately \$130 million in savings to the community. These savings include \$16 million in reduced energy expenses; \$5 million in avoided CO₂ damage; and \$109 million in reduced auto/truck driving expenses.

An additional 70 CO₂ reduction measures have been identified by the Task Force as suitable for further implementation as the community strives to achieve the international CO₂ reduction goal (see Appendix F). An important component of the overall effort will be periodic evaluation of the community's progress and fine tuning of implementation measures.

Table ES-1
ACTION MEASURES

	2010 CO₂ Savings (tons/yr)
1. <i>Municipal clean fuel vehicle purchases.</i>	251
2. <i>Private fleet clean fuel vehicle purchases.</i>	3,471
3. <i>Municipal clean fuel demonstration projects.</i>	2,722
4. <i>Telecommuting and telecenters.</i>	367
5. <i>Municipal building upgrades and employee trip reduction.</i>	799
6. <i>Enhanced pedestrian connections to transit.</i>	6,328
7. <i>Increased housing density near transit.</i>	8,744
8. <i>Site design with transit orientation.</i>	4,372
9. <i>Increased land-use mix.</i>	8,744
10. <i>Reduced commercial parking requirements.</i>	6,328
11. <i>Site design with pedestrian/bicycle orientation.</i>	4,372
12. <i>Bicycle integration with transit and employment.</i>	2,417
13. <i>Bicycle lanes, paths, and routes.</i>	1,447
14. <i>Energy efficient landscaping.</i>	1,279
15. <i>Solar pool heating.</i>	2,462
16. <i>Traffic signal and system upgrades.</i>	1,640
17. <i>Student transit subsidy.</i>	3,878
18. <i>Greenstar building efficiency program.</i>	15,591
19. <i>Municipal life-cycle purchasing standards.</i>	10,151
20. <i>Increased employment density near transit.</i>	<u>13,355</u>
TOTAL	98,379

1. INTRODUCTION



WHY A CO₂ PLAN?

Significance for Chula Vista

Based on 1990 data, each person in Chula Vista creates about eight tons of carbon dioxide (CO₂) emissions every year. CO₂ is the gaseous product of incomplete combustion of fossil fuels, such as gasoline and natural gas. Of the seven major greenhouse gases, the highly heat absorbing character of CO₂ causes it to have the most direct impact on global climate. Research has estimated that approximately 75% of the global greenhouse effect is attributable to CO₂ emissions, and over 90% of Chula Vista's greenhouse gas emissions are CO₂. This section describes potential impacts and assumes no mitigation measures, beyond those currently practiced, to reduce carbon dioxide emissions.

The development of this plan is the culmination of 2 years by the City's task force and 3 years of participation in the International Council of Local Environmental Initiatives cities project. Each city selected for the program was responsible for developing a plan for implementation.

Global climate change is not just another environmental issue. Since the 1980s, virtually all international investigations have confirmed that human activity is changing the atmosphere at an unprecedented rate, and that these changes constitute major threats to the economic and environmental health of communities worldwide, including Chula Vista. If allowed to continue, global warming could potentially impact Chula Vista in several significant ways: rising ocean level and flooding of coastal areas; higher prices for water, electricity, and farm products; adverse changes in fragile ecological systems; poorer air quality; increases in certain illnesses; and jeopardized economic health.

The Scientific Debate

Until recently, the scientific community debated whether global warming was a natural phenomena or not, and if so, what were the effects. The uncertainty has provided skeptics with ammunition to argue against taking steps to reduce the 'potential' impacts. But now, the United Nations International Scientific Panel on Climate Change (IPCC), a respected U.N.-sponsored body made up of more than 1,500 leading climate experts from 60 nations, came out with an unprecedented report that for the first

time ever, presents that global warming can be blamed, at least partially, on human activity. This report is critical in that the IPCC had been reluctant to make such a connection until consistent and agreed-upon scientific evidence demonstrated this to be true. This shift in scientific consensus is not so much based on new data but on improvements in the complex computer models climatologists use to test these theories. Additionally, a number of studies have also added to the scientists' confidence that they can generally predict what may happen if greenhouse gases continue to be released into the atmosphere unchecked (excerpt from Time Magazine October 2, 1995). Of course, the issue has proponents on all sides, since it is not a clearly visible issue yet in the United States.

Why pick on cities? Most of the world's 500 million vehicles are in cities. Cars produce about 60% of smog forming emissions. City planning results in either more or less utilization of cars. How long it takes to get from point A to point B results from where residential versus commercial areas are designated. The proposed plan attempts to take these principles into account throughout the document and its policy measures.

It is important to note that the City's plan does not predict these impacts with certainty. It instead examines them as potential impacts resulting from a hypothetical set of climate circumstances if current trends continue. The City's plan to reduce Chula Vista's CO₂ emissions is based largely on energy efficiency improvements. Chula Vista gains valuable economic, environmental, and social benefits from the energy savings that come with CO₂ reductions.

Global Economic Impacts

Studies of the economic impact of climate change by the Intergovernmental Panel on Climate Change (IPCC) are being carefully examined by the international insurance and banking industries. The insurance industry believes that an unprecedented series of hurricanes, floods and fires may be the first real effects of human-induced climate change. These companies are spending millions of dollars on climate studies because of the millions of dollars in insurance claims paid, resulting from weather-related disasters. The insurance industry is interested in climate change because in the last 100 years, the worst natural disasters and largest insurance claims occurred in just the last six years. 1995 was the hottest global year on record and it follows a string of record breaking years that built to a crescendo just before the dust of the Mt. Pinatubo volcanic eruptions blocked accumulation for several years. Even the record breaking cold weather is potentially a result of more solar energy trapped in the earth's atmosphere by greenhouse gases.

The Washington Post reported January 21, 1996 a mood shift in the international businesses coming about by nothing less than the brute strength of the marketplace. Recent major disasters caused by extreme climate events could literally bankrupt the insurance industry in the next decade. U.S. business interests are just beginning to see their stake in the debate. The Post reported on a memorandum prepared by the Assistant Director of the British Bankers' Association, intended for the Bankers' annual meeting of chief executive officers. The memo warned that more than half of all current bank lending is "affected by environmental factors" and that within the 20-40 year "life-time of loans granted today, climate change is forecasted to have dramatic impacts". By the same token, Blackman drew his colleagues attention to the profitable silver lining, stating "there are enormous opportunities available to finance new environmental developments and the development of alternative energies" extending well beyond specific technologies like solar collectors and electric cars. Broadly defined "the environment could become the biggest market of the 21st century."

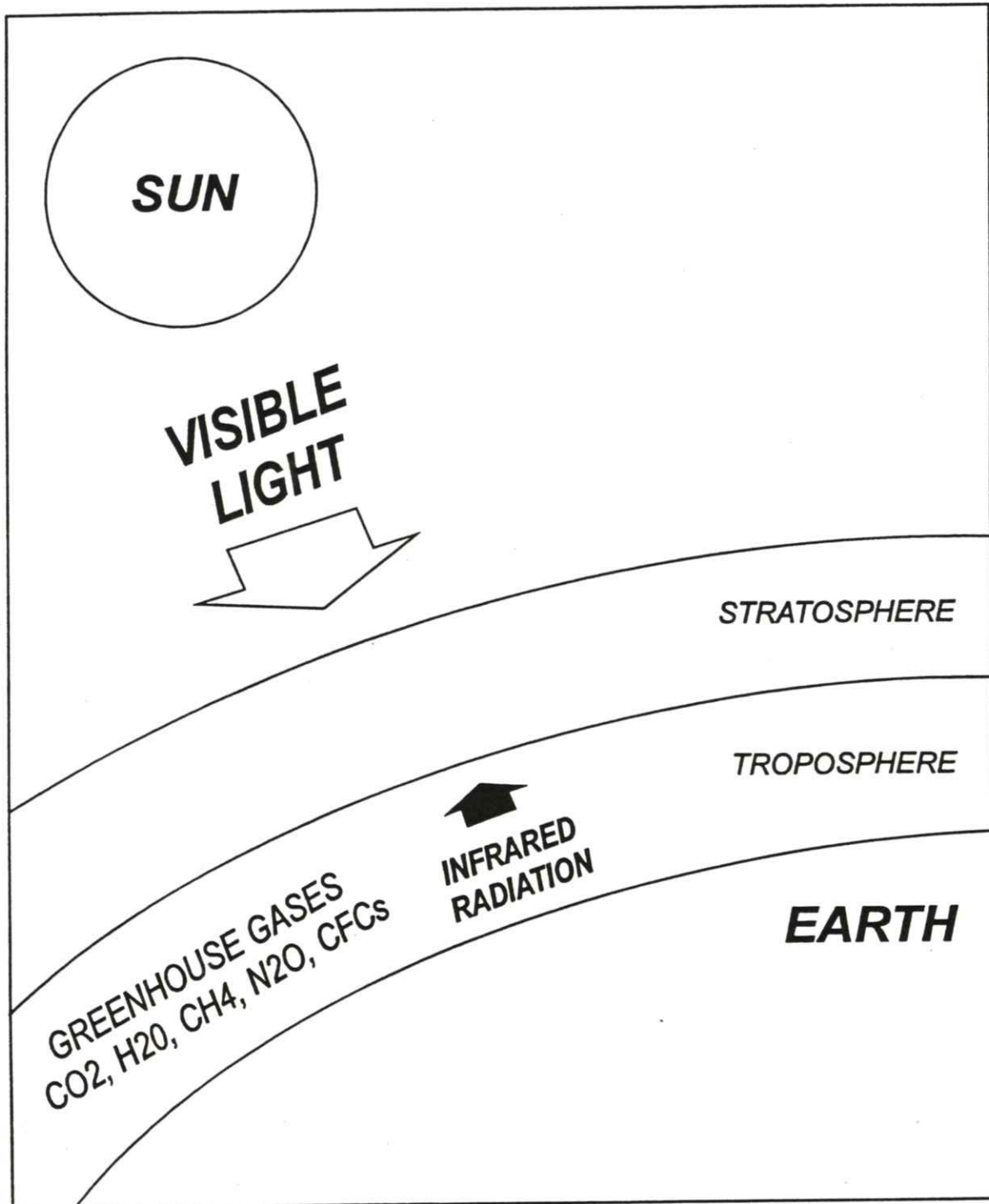
The Greenhouse Effect

The greenhouse effect keeps Chula Vista (and the earth) warm. Sunlight passes through the atmosphere and warms the earth's surface, and the earth then radiates infrared energy. Trace gases and water vapor absorb part of the infrared radiation and emit some back, further warming the atmosphere. The problem is that concentrations of these gases are increasing at higher than natural rates, and most scientists agree that these increases could significantly affect the global climate.

Naturally occurring gases in the atmosphere trap heat in the physical process termed the greenhouse effect. As shown in Figure 1.1, surface temperatures on earth are determined by radiation from the sun and the physical properties of atmospheric gases. These gases, known as greenhouse gases, allow solar radiation to pass through the earth's atmosphere to heat the earth's surface. This heat is then re-radiated from the earth in the form of infrared energy. Greenhouse gases absorb part of this radiation in the process known as the greenhouse effect.

Five naturally occurring atmospheric gases are responsible for the greenhouse effect: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), tropospheric ozone, and water vapor. These gases are naturally transferred between the land, atmosphere and ocean. For example, plants absorb carbon dioxide through photosynthesis as they grow, store it in solid form during the life of the plant, and release it again as a gas when they die and decompose. Carbon can be stored for longer periods of time, sometimes for millions of years, in the form of coal, oil, and natural gas.

Figure 1.1
THE GREENHOUSE EFFECT



Source: CEC, 1991.

The greenhouse problem arises with human activity upsetting the equilibrium of gas concentrations by releasing carbon, methane, and other gases faster than oceans, plant matter, and soils can absorb them. For example, the carbon in oil would be released very slowly under natural circumstances, but because we are driving gasoline-powered automobiles in ever increasing amounts, the release of carbon occurs more quickly. This rising build-up of greenhouse gases is leading to warmer global temperatures, or the effect known as global warming.

Potential Impacts of Global Warming

It is not possible to predict with certainty what will happen to Chula Vista as a result of global warming, but research has enabled the California Energy Commission (CEC) to assemble a hypothetical set of impacts for the state. This scenario assumes a doubling of CO₂ emissions by 2050 with a 5.4° F (or 3° C) temperature rise as a result. These increased CO₂ emissions could impact water, energy, agriculture, forestry, ocean level, natural habitat, outdoor recreation, air quality, health, and the economy. Of these impact areas, the following seven subsections describe those that may potentially apply to Chula Vista. These seven subsections have been excerpted from the CEC 1991 report entitled Global Climate Change Potential Impacts and Policy Recommendations:

Potential Energy Impacts

Temperature increases projected from global warming may increase electricity demand while reducing electricity supply. The primary temperature-sensitive electric end-uses in California are the heating and cooling of residential and commercial buildings. Considering only changes in heating and air conditioning, a 3° C temperature rise could increase net annual electricity use as much as 2.5%. Decreases in wintertime space heating demand would not offset the much larger increase in summertime air conditioning demand. Because California's electric utilities experience their peak demands in the summer, warming-induced increases in air conditioning load could lead to peak demand increases of as much as 6%. As demand for electricity increases, associated carbon emissions from electric generation could also increase, depending on the fuel mix used to generate the additional electricity. At the same time, warming could change the amount and timing of hydroelectric supplies, since warming may reduce the volume of winter snowpack.

Potential Ocean Level Impacts

Sea level rise is expected to occur as a result of thermal expansion of the ocean surface, melting of the earth's glaciers and polar ice fields, and mixing of now stratified ocean waters. The current rate-of-rise would cause ocean levels in San Francisco Bay to rise as much as 5 inches in the next 50 years. A recent EPA study estimates that if temperatures rise 3° C by 2050, a one-meter (or approximately 3 foot) sea level rise could result by 2100. Coastal erosion also is expected to increase due to sea level rise. Higher seas provide a higher base for storm surges and have the potential for more destructive storm activity.

Potential Water Impacts

Global warming may decrease water supplies from surface sources, increase water demand, increase the occurrence of winter flooding, and make water pollution more severe. Since the amount of water stored in mountain snowpack is primarily a function of winter snowfall, a 3° C temperature rise could raise California's historical snowlines by approximately 1,500 feet, which would reduce the average snowpack area 52%. Global warming may also magnify water quality problems by reducing spring and summer flow in rivers and their ability to dilute existing and anticipated pollutant loading.

Potential Air Quality Impacts

Changes in temperature, atmospheric ventilation, solar radiation, and precipitation may affect air quality in California both adversely and positively. However, since the impact of global warming on local climate cannot be confidently predicted, the magnitude of these effects is unknown. Climate change may adversely affect regional air pollution levels because of higher temperatures, increased ultraviolet radiation, and possible increases in precipitation. However, changes in wind patterns could worsen pollution problems, or they could help flush pollutants from urban areas. The potential impacts of global warming on the state's major air pollutants are:

- **Ozone**—Higher temperatures and increased ultraviolet radiation accelerate the chemical rates of reaction in the atmosphere, leading to higher ozone concentrations. Higher temperatures also cause increases in emissions of oxides of nitrogen (NO_x) and hydrocarbons, the two precursors for ozone. More electricity demand in summer months could lead to higher NO_x

emissions from utilities. Evaporative emissions of hydrocarbons from motor vehicles, refueling, and deciduous trees also increase with temperature.

- *PM₁₀*—Increased chemical rates of production due to higher temperature and increased ultraviolet radiation lead to higher PM₁₀ concentrations. Precursor emissions of NO_x, sulfur oxides (SO_x), and soot and ash from stationary and transportation sources may rise in summer because of increased energy demand for air conditioning. Nitrate may increase or decrease depending on both temperature and relative humidity. In winter, changes in the frequency and intensity of inversions may work to reduce trapping of vehicle exhaust. Since human outdoor activity is greater in summer than in winter, longer warm seasons and less intense winters may increase the comparative importance of summer-type aerosol exposure in major urban areas.
- *Acid Disposition*—Possible increases in acid deposition due to more electricity demand (higher NO_x and SO_x emissions), higher temperatures and drier, warmer conditions
- *Carbon Monoxide*—CO is a product of incomplete combustion, and is primarily a winter problem in California. Air pollution levels may benefit from warming induced increased atmospheric ventilation at night. A shorter winter season and possible reduced frequency of inversions may reduce frequency, but not necessarily severity, of CO “hot spots” due to motor vehicles.

Potential Economic Impacts

Global warming could have a dramatic impact on California’s economy. Most of the impacts discussed above would ultimately have economic consequences. Changes in water supplies and air quality, for example, have direct and indirect economic consequences. The California economy and its relationship to the global economy is also extremely complex and the ways in which climatic change could affect it are similarly complex. Some of the basic impacts could include:

- *Higher prices*—for water, electricity, fuels, farm products, and for goods requiring the input of these primary goods.
- *Changes in trade*—resulting from changes in the availability and prices of some goods, changes in the economies of trading partners, and changes in the overall global economy. Some

researchers estimate that the climate changes resulting from an effective CO₂ doubling will reduce global economic growth by three percent per year.

- *Changes in demographics*—as a result of increased “economic and environmental refugees” from areas in the world that experience significant climate drying, warming, or economic disruption. This may be of particular significance for North America, where immigration to California may be easy. The possibility of immigration out of California as a result of these trends must also be recognized. A larger difference between income levels and economic strata within California may result.
- *Shift of investments*—from normal investments in the economy to investments necessary for accommodating a warming, thereby reducing available capital necessary for maintaining a robust and growing economy.
- *Changes in the riskiness of investments*—as a result of climate circumstances outside the experience of most investors. This could cause upward pressure on interest rates and cost of capital, further constricting the availability of discretionary capital.

Potential Natural Habitat Impacts

Warmer temperatures, sea level rise, and changes in water availability could result in substantial impacts to threatened and endangered species, particularly coastal wetlands and wetlands species. Changes in temperature, rainfall, or other significant climatic effects could have devastating effects on sensitive species. Global warming could affect estuaries and low-lying wetlands through sea level rise by greater variation in seasonal freshwater in-flow and salt-water intrusion. A 3° C warming could also cause land-based vegetation belts to shift northward by as much as 200 miles. A climatic change of this magnitude would require that species shift distribution several miles each year or physiologically adapt to the warming. The mobility of some wildlife species may enable them to achieve this rate, but most plant species could not shift this quickly. Marine habitats could also be affected if global warming shifts ocean upwelling patterns and associated nutrient transport. The shift could precipitate a change in the location of productive fisheries along the coast.

Potential Human Health Impacts

Increased warming may endanger the health of thousands of citizens. Each of the state's major air pollutants is associated with a set of health problems. These are discussed below in relation to global warming:

- *Ozone*—Ozone exposures of several hours, at levels currently experienced in California, cause airway constriction in as many as 20% of healthy exercising adults and children. Other lung changes indicative of actual lung injury also occur. Increased duration and level of ozone exposure increases both the severity of the response and the number of individuals who respond. Years of ozone exposure can result in structural alterations in the lung and contribute to a cumulative lifetime decrease in lung function. Increased frequency and severity of ozone exposure will most likely increase the rate at which long-term changes occur and also increase the total ozone contribution to lifetime lung injury.
- *PM₁₀*—Adverse health effects of fine particles include chronic reduction of lung function and specific toxic effects of various components of the aerosol mass. Clinical and epidemiologic studies indicate PM₁₀ contributes to increased incidence of emphysema, aggravation of asthma, and transmission of airborne pathogens.
- *Carbon Monoxide*—CO is a toxic gas that acts by blocking transport of oxygen by the blood. Exposure has been shown to aggravate chest pain in patients with coronary heart disease. Both individuals with chronic heart disease and respiratory problems are at greater risk.

Global warming could increase concentrations of these pollutants, and the CO₂ increase presently projected would likely result in both increased morbidity (illness) and mortality (death) among citizens. The elderly and the very young would be most severely affected. More than 70% of the increased mortality in adults would occur in persons above the age of 65; most of these would result from exacerbation of coronary heart disease and stroke. Global warming may also indirectly lead to an increase in the number of premature births and perinatal deaths (deaths occurring before, during, or just after birth). Increase in the number of preterm births and perinatal deaths are generally associated with warmer summer months. Preterm birth increases the risk of both morbidity and mortality in developing infants, and therefore increased morbidity and mortality should be expected among these infants."

In addition to these potential impacts of increased global warming, City staff have requested information on criteria pollutant impacts from CO₂ emission reductions. In other words, while CO₂ increases could potentially degrade air quality as described above, what are the potential air quality impacts of CO₂ reductions? The answer to this question depends upon the type and magnitude of CO₂ reduction measures implemented. In the buildings sector, measures that reduce energy consumption will produce criteria pollutant reductions proportionate to CO₂ reductions. Measures involving fuel switching from fossil fuels to renewable energy resources will completely eliminate criteria pollutant emissions along with CO₂ emissions. In the transportation sector, measures that eliminate or reduce driving will produce criteria pollutant emission reductions proportionate to CO₂ reductions. However, measures that create mode or fuel switching may increase certain criteria pollutant emissions depending upon site-specific circumstances. For example, shifting passengers from autos to transit may not result in a net criteria pollutant improvement if the average transit vehicle occupancy is relatively low and transit vehicle fuel is more polluting than auto fuel, e.g. diesel versus gasoline. The CEC has sponsored research on the air quality impacts of various transportation modes and fuels, and has concluded that the large number of variables makes it impossible to generalize about the criteria pollutant effects of CO₂ reduction (Delucchi, 1995). This wide range of potential impacts is shown in Table 1.1 where percentage changes in emissions per passenger trip are compared for transit versus autos in four California regions. Based on these results, the CEC has determined that the air quality effects of CO₂ reduction measures must be analyzed on a case-by-case basis.

International CO₂ Reduction

Chula Vista has undertaken this CO₂ reduction effort as part of the international, multi-city Urban CO₂ Reduction Project. Sponsored by the International Council for Local Environmental Initiatives (ICLEI), the Urban CO₂ Project includes a group of 14 cities worldwide who are committed to demonstrating local leadership on climate change. Table 1.2 provides a sample of the CO₂ reduction actions being taken by these cities. The Urban CO₂ Project was initiated in 1991, and Chula Vista joined the effort in 1993.

Starting with the Toronto Conference on the Changing Atmosphere in 1988, the international scientific community proposed that a global reduction of 1988 CO₂ emissions of 20% by the year 2005 should be a target if a 50% reduction of 1988 emissions is to be achieved by 2050. The United Nations Environment Program and the World Meteorological Organization established the Intergovernmental Panel on Climate Change (IPCC) to develop further understanding of the problem and formulate policy options for the international community. In 1990, the Second World Climate Conference in Geneva

Table 1.1
**PERCENTAGE CHANGE IN EMISSIONS PER PASSENGER TRIP
 USING TRANSIT IN PLACE OF AUTOS**

	Sacramento	San Francisco	Los Angeles	San Diego
NMHC	-97.5%	301.3%	-44.4%	-7.2%
CO	-91.3%	87.3%	48.6%	-83.7%
NO _x	-70.5%	39.9%	148.4%	-71.2%
SO _x	84.7%	-5.4%	-89.5%	66.0%
PM ₁₀	-91.5%	-93.1%	-12.0%	-92.3%
C ₆ H ₆	-99.0%	87.5%	1013.2%	93.1%
HCHO	-87.9%	111.1%	1845.7%	-67.8%
CH ₃ CHO	-88.4%	4490.4%	-82.5%	-91.4%
CH ₂ CHCHCH ₂	-98.6%	infinite	375.9%	infinite
CH ₂ CH ₂	-93.6%	infinite	25.2%	-94.2%
Fuelcycle GHG	-87.5%	19.1%	52.8%	-59.4%

NMHC = nonmethane hydrocarbons; CO = carbon monoxide; NO_x = nitrogen oxides; SO_x = sulfur oxides; PM₁₀ = particulate matter of less than 10 microns; C₆H₆ = benzene; HCHO = formaldehyde; CH₃CHO = acetaldehyde; CH₂CHCHCH₂ = 1,3 butadiene; CH₂CH₂ = ethylene (ethene).

Source: Delucchi, M.A., *Emissions of Criteria Pollutants, Toxic Air Pollutants, and Greenhouse Gases From the Use of Alternative Transportation Modes and Fuels*, CEC, 1995

1. Introduction

Table 1.2
LOCAL CO₂ REDUCTION EFFORTS WORLDWIDE

City	Sector	Program	Voluntary/ Mandatory	Implementation	Instituted	Cost	Impact/Goal
Portland	Commercial	Sustainable Tomorrow (BEST)	V	Brokerage service by City that provides educational, technical, financial assistance to local businesses.	1992	\$40-70,000 annually	Local economic development and environmental protection; more than 140 businesses have participated.
Dade County	Land-Use	Neighborhood Development	M	Integration of homes with work, commerce, leisure.			Projected 30-40% fewer daily auto trips.
St. Paul	Municipal	Environmental-Economic Partnership Project	N/A	Survey of 48 environmental-related activities of city government, with economic implications. Report presents range of options for each activity.	1994		Impact varies by department: Public Works saves \$250,000 annually; Parks and Recreation saves \$500,000; other departments enjoy reduced energy consumption and CO ₂ emissions.
Phoenix	Municipal	Energy Conservation Reinvestment Plan	M	City reinvests half of energy savings each year to finance new energy efficiency projects.	1984	\$10,000,000 initial investment	Yielding \$18,000,000 savings by 1992.
Toronto	Municipal	Energy Efficiency Office	N/A	Developing a plan to retrofit city-owned buildings with high-efficiency lighting and to upgrade communal housing.	1990	\$23,000,000 endowed fund	Goal of reducing CO ₂ emissions by 20% from 1988 levels by 2005.
Denver	Municipal	Green Lights Project	M	Covert 90% of city's lighting to efficient technologies.		\$5,000,000 over five years	
Austin	Residential	Energy Star and Green Builder Programs	V	Incentive programs rewarding low-impact environmental behaviors/ components in residential construction.	1986, 1991	\$150,000/yr	More than 90% of the houses built since 1986 have been rated; more than 50 separate builders have participated in the program.
Saarbrücken	Residential	Saarbrücken Participation Program	V	Low-interest loans (subsidized by municipal utility) for residential retrofits of energy conservation investments.	1980	3-5 million DM/yr	Related energy education program has reduced CO ₂ emissions 15%.
Saarbrücken	Residential	Solar Rooftop Program	V	Local bank set up loan program for residential retrofits of photovoltaics; residents can sell this solar power to utilities.		as above	Goal of one megawatt of generating capacity on rooftops.
Ankara	Residential	Residential Fuel Conversion	M	Conversion from coal/fuel oil to natural gas for residences.			
Copenhagen	Residential	District Heating	M	Mandatory expansion of district heating.			From current 65% rate to 95% by 2002.
Seattle	Municipal/Transport	City Employee Commute Trip Reduction Program	M	Provides public transportation subsidies, parking subsidies for carpools, telecommuting, etc. to reduce number of drive-alone trips.	1993		Goal to reduce single-occupancy vehicle rate.

Source: ICLEI

reviewed the work of the IPCC, the result of which was a commitment to prepare an international convention on climate change for the Earth Summit in 1992.

The resulting Framework Convention on Climate Change (FCCC) was signed by more than 150 countries at the Earth Summit. The Convention stops short of a firm target and schedule for greenhouse gas emission reductions. A number of countries, including the United States, have since made unilateral commitments to bring greenhouse gas emissions to their 1990 levels by the year 2000.

In April 1995, the signatories to the FCCC met in Berlin to re-evaluate emission targets. At this meeting, the countries made a new commitment, known as the Berlin Mandate, under which they will try to set new emission targets for the years after 2000 by 1997. Though the scientific evidence for global warming is still inconclusive, the decision reflects broad agreement that reducing the output of greenhouse gases is a sensible precaution until more is known about their effect on the global climate.

At ICLEI's recommendation, this initial Chula Vista plan is interpreting the international goal to be 80% of 1990 emissions in 2010. Chula Vista can respond to subsequent FCCC targets during future updates of the CO₂ plan.

Developing the Plan

The process used to prepare Chula Vista's plan is illustrated in Figure 1.2. A 25-member Task Force of interested stakeholders was assembled in May 1994 to oversee the plan's preparation. Using staff and consultant assistance, the Task Force inventoried existing CO₂ emissions; projected emissions growth to 2010; and evaluated a wide range of CO₂ reduction measures to identify those most suitable for Chula Vista. This process culminated in the reduction strategy, policies, and implementation measures described in the plan's concluding chapters. The geographic scope of the plan is shown in Figure 1.3, which illustrates the City's general planning area in relation to the San Diego region.

Measuring CO₂ and Energy

Planning for CO₂ emission reductions and related energy efficiency improvements requires the measurement of CO₂ and various energy quantities. In this plan, CO₂ is expressed as a function of fuel type by weight, in either pounds or tons (short tons of 2,000 lbs.). For example, 87 gallons of gasoline is equivalent to about one ton of CO₂. As shown in Figures 1.4, 1.5 and 1.6, about half of this comes from automobile driving and gasoline; another quarter comes from energy use in homes, much of that in electricity; and the remainder comes from energy use in stores, offices, industries, and municipal government.

Figure 1.2
CHULA VISTA CO₂ REDUCTION PLANNING PROCESS

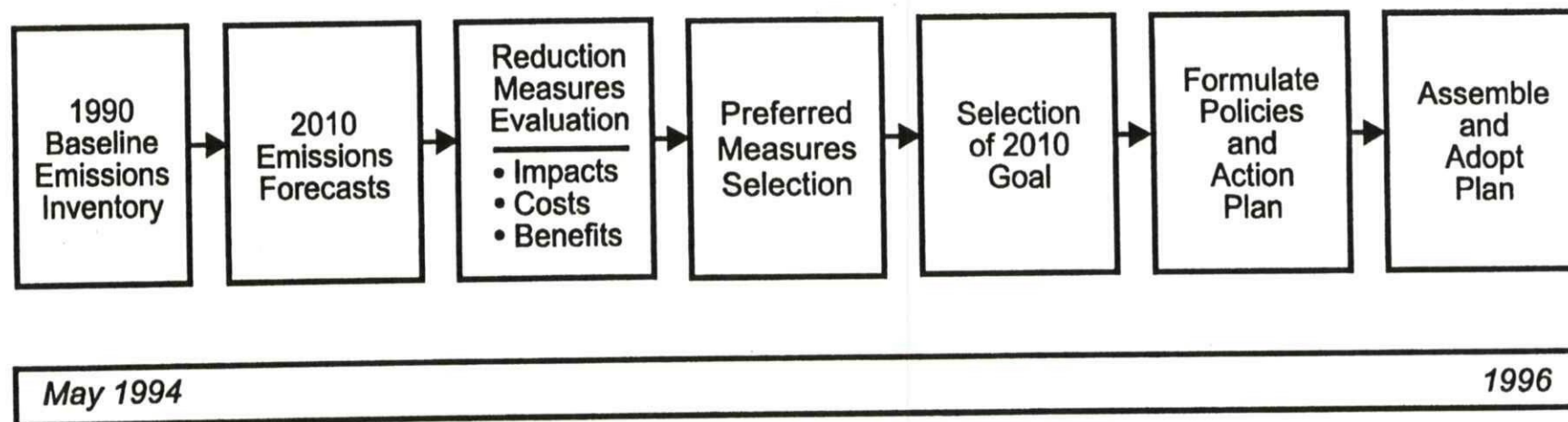


Figure 1.3
CHULA VISTA PLANNING AREA & VICINITY

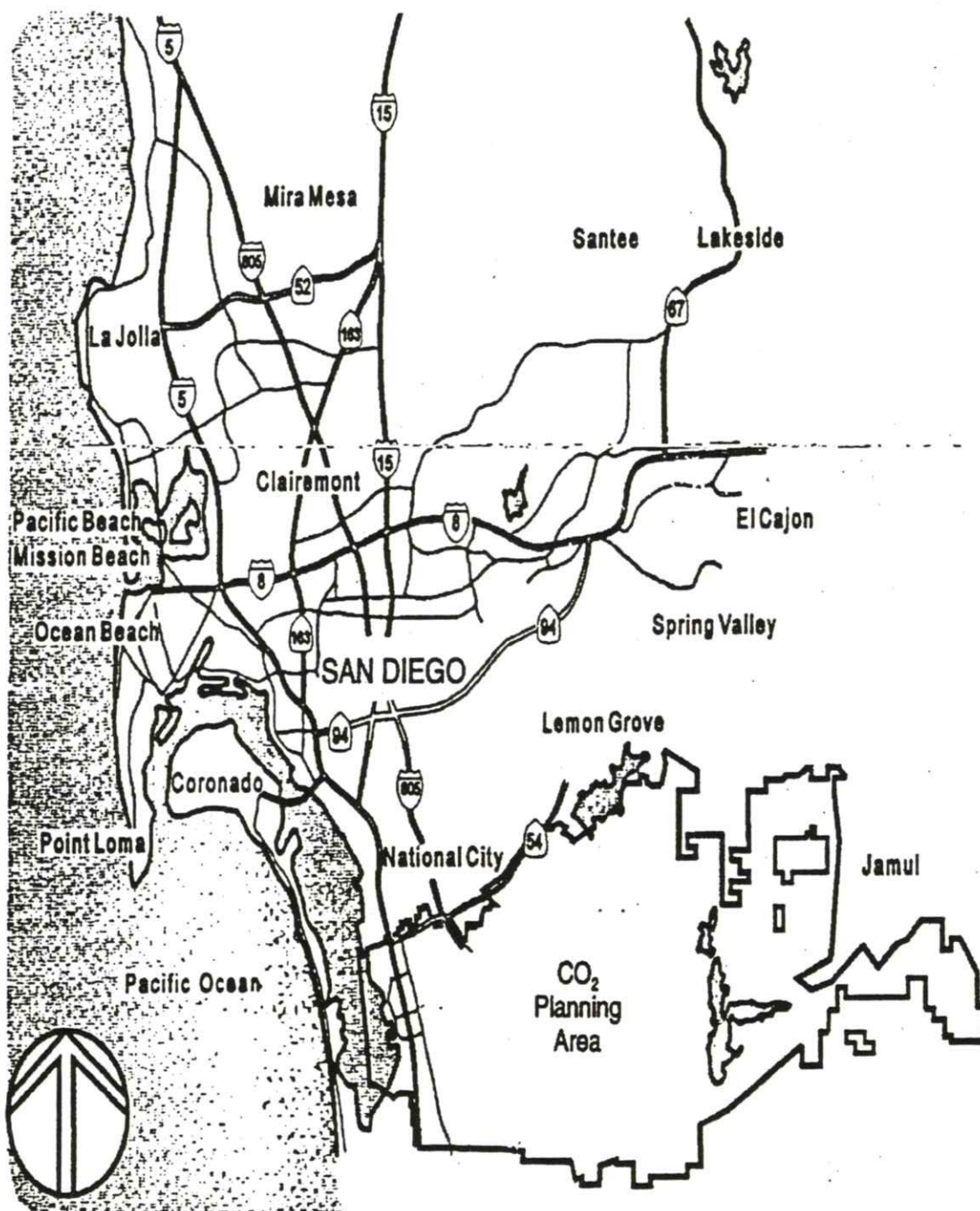


Figure 1.4

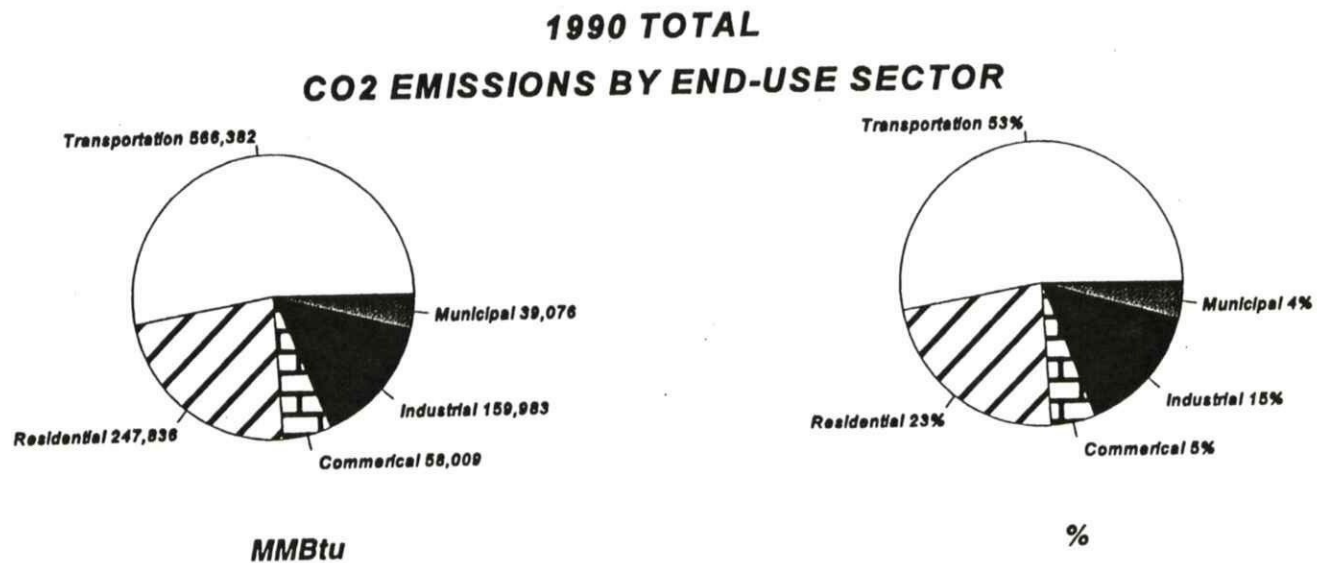
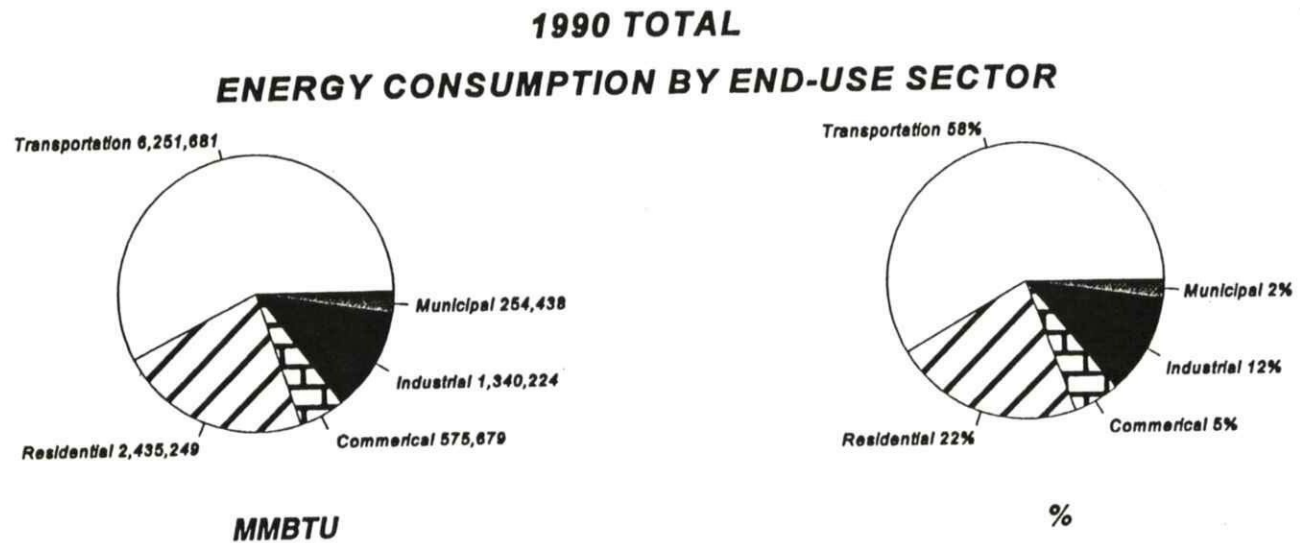
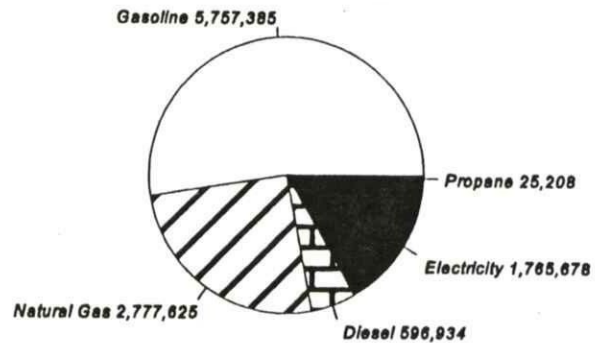
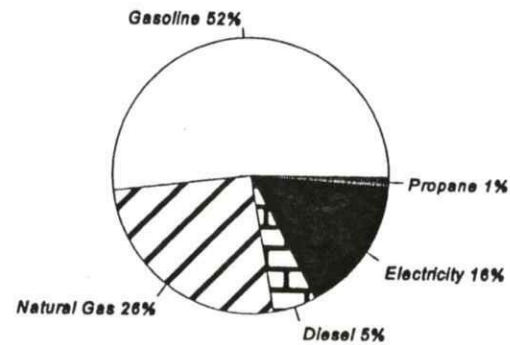


Figure 1.5

**1990 TOTAL
ENERGY CONSUMPTION BY FUEL TYPE**

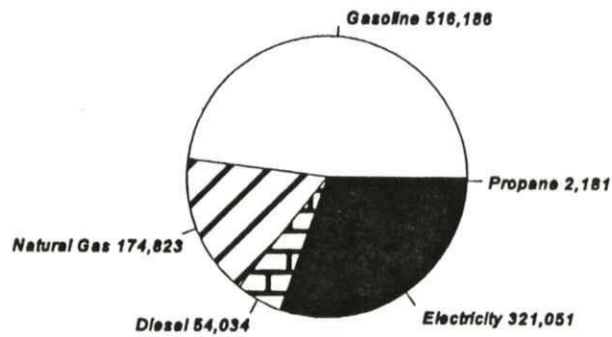


MMBtu

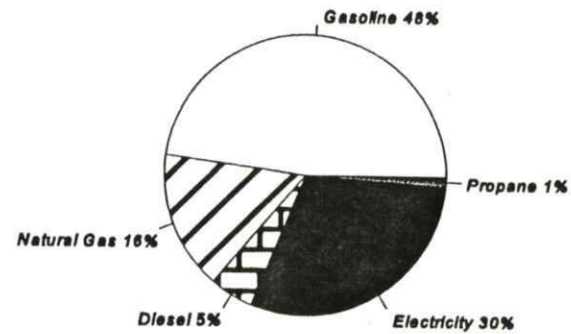


%

**1990 TOTAL
CO2 EMISSIONS BY FUEL TYPE**

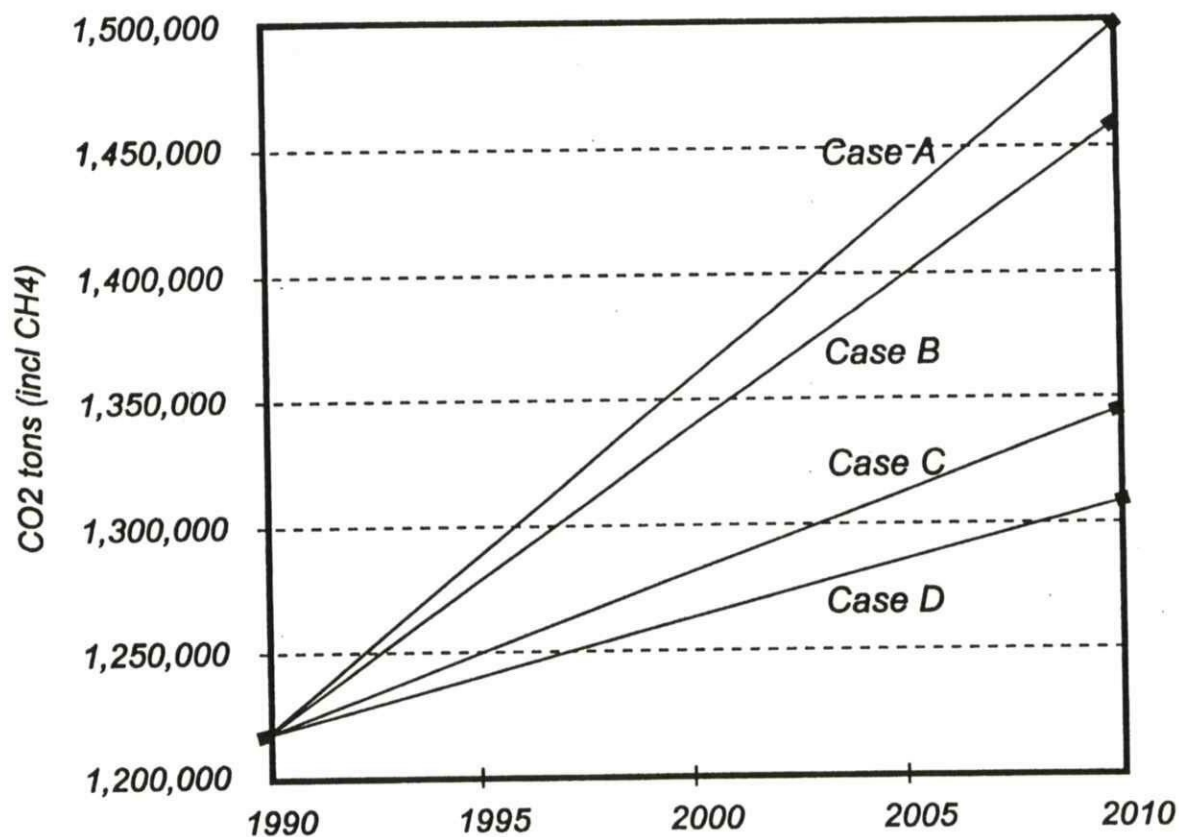


MMBtu



%

Figure 1.6
2010 CO₂ FORECASTS WITHOUT MUNICIPAL ACTIONS



Case:

A: Population and VMT growth only.

B: Electric resource mix improvement. Due to utility deregulations, this scenario is no longer valid, according to SDGE.

C: Vehicle efficiency improvement.

D: Electric resource mix and vehicle efficiency improvements.

Energy use involves a variety of fuels that are measured in their own unique units. Electricity, for example, is normally expressed in kilowatt/hours while gasoline is measured in gallons. To simplify tabulations, all energy values are converted into British thermal units (Btu). One Btu is the amount of thermal energy required to raise the temperature of one pound (one pint) of water 1° F at sea level. Because a single Btu is a relatively small amount of energy, one million Btu (MMBTU) is used as a standard unit throughout the plan. Table 1.3 presents conversions of various fuels into Btu equivalents according to energy and CO₂ content.

Two other statistical notes: 1) methane (CH₄) is addressed intermittently throughout the plan, and in those instances it is measured in equivalent CO₂ units; and 2) CO₂ emissions are often expressed in pounds or tons per capita, which is the total amount of CO₂ from a given source divided by Chula Vista's total population. This latter expression is intended to give citizens better insight into how their personal actions contribute to the community's global warming emissions.

Table 1.3
ENERGY AND CO₂ CONVERSIONS

	<u>MMBtu</u>	<u>CO₂</u>	
		<u>Lbs</u>	<u>Lbs/MMBtu</u>
<i>One gallon of gasoline</i>	0.1250	19.37	152
<i>One gallon of diesel</i>	0.1390	23.57	169
<i>One therm of natural gas</i>	0.1000	12.58	116
<i>One kilowatt-hour (kWh) of electricity</i>	0.0034	1.24	364
<i>(based on SDG&E's 1990 resource mix)</i>			

One ton of CO₂ = *87.02 gallons of gasoline*

One ton of CO₂ = *159 therms of natural gas*

One ton of CO₂ = *1,610 KWh of electricity*

2. EMISSIONS INVENTORY



1990 BASELINE INVENTORY

CO₂ Emission Sources

The first step in Chula Vista's CO₂ reduction planning is the establishment of a baseline to measure reductions against: how much CO₂ is Chula Vista currently emitting, and what are the sources of those emissions? 1990 was selected as the plan's baseline year because that was the most recent year of complete data, and it is also consistent with the baselines used by most ICLEI cities. The sources of Chula Vista's emissions are categorized as follows:

Energy consumption

- Petroleum use in autos, trucks, and other equipment.
- Electricity and natural gas use in homes and businesses.

Energy production

- Petroleum refining
- Electric power generation
- Natural gas distribution

Each of these components are summarized below and detailed in Appendices A and B.

Energy Consumption

Emissions are directly created by energy consumption when fuel is combusted by end-users, such as motorists using gasoline and homes and businesses using natural gas. Emissions are indirectly created by electrical use, i.e., using electricity in a home requires generation at a power plant that, in turn, emits CO₂. Chula Vista's energy consumption is organized into five end-use sectors: municipal government, transportation, residential, commercial, and industrial.

Municipal Government

Chula Vista's municipal government uses energy in three ways: fueling municipal-owned vehicles; space conditioning and powering municipal-owned buildings; and powering certain public services, such as street lighting and park irrigation. Municipal energy use accounts for only 2% of total community energy use. This energy consumption generates about 39,000 tons of CO₂ emissions annually, and 80% of that comes from electric use. Although municipal government energy consumption is the smallest end-use sector, it nonetheless is most directly subject to public policy and can therefore be used to set a leadership example for other sectors. It also represents a \$4.4 million annual expense in the municipal budget. Using energy more efficiently not only reduces CO₂ emissions, but also saves money that can be redirected to other critical public service needs.

Transportation

As a suburban community, based upon 1990 census data, a total of 54,200 Chula Vista residents commute to work outside of Chula Vista. As a bedroom community to San Diego, the inventory identified Chula Vista's largest energy end-use sector and CO₂ emitter as transportation. Because of Chula Vista's suburban nature, it is understandable that the largest identified contributor to CO₂ emissions reflects the community's dependence on automobiles for a large majority of its travel needs. Chula Vistans use approximately 106,000 automobiles and trucks to travel over one billion miles annually, emitting nearly 600,000 tons of CO₂ in the process. This includes travel both within Chula Vista and for commute trips to other parts of the San Diego region. This sector represents slightly over 50% of the community's annual CO₂ emissions, indicating heavy dependence on low occupancy automobiles that are the City's single highest contributors to CO₂.

Residential

After transportation, the second largest energy user is Chula Vista's residential sector. This sector included 49,849 dwelling units in 1990, 46% of which were detached single-family homes, and 24% of which were apartment buildings with ten or more units. Chula Vista's residences are relatively young; 23% were built since 1980, and another 60% between 1950 and 1980. In total, this sector accounts for 22% of the community's total energy use. About one-third of the residential energy used is electrical, and two-thirds is natural gas. This energy consumption creates approximately 248,000 tons of CO₂ annually, or 23% of total emissions.

Commercial

The community's commercial sector is dominated by retail and service trades. These are estimated to consume about 5% of total community energy, and to produce approximately 91,000 tons of CO₂ emissions every year. It should be noted that SDG&E has provided electric and natural gas end-use data for commercial and industrial sectors combined, making it necessary to estimate the commercial share. This estimate can be refined if and when actual commercial sector data become available.

Industrial

Chula Vista's industrial sector includes aerospace manufacturing and other light industries. This sector is estimated to consume about 12% of total community energy and to emit about 157,000 tons of CO₂ annually. Again, SDG&E only provided combined commercial and industrial data, making it necessary to estimate the industrial share. This can be refined if and when actual industrial data are made available.

Energy Production

The second portion of the 1990 inventory are those emissions created during energy production and distribution. For example, electric power plants and petroleum refineries emit CO₂ when producing their output, and large pipelines may emit CO₂ or CH₄ through venting or flaring during product distribution. These sources are organized by energy type, and further by their location either in Chula Vista or elsewhere but serving Chula Vista.

Electricity

Electricity is provided in Chula Vista solely by SDG&E (excepting for a small number of "self-generators," which are facilities that operate small power plants for their internal use). SDG&E generates electricity from power plants that it owns and operates throughout San Diego County, including the 700 MW South Bay plant in Chula Vista. It also purchases power from independent producers throughout the County, including several in Chula Vista, and from other utilities outside the region. Chula Vista experiences power plant CO₂ emissions far in excess of its own electric needs, with about 2.8 million tons of CO₂ coming from local power plants alone every year. In contrast, the community's electric end-use creates only about 300,000 tons/year of CO₂ emissions.

It is also worth noting that what is normally a community's largest source of methane emissions, the solid waste landfill, is being put to beneficial use in Chula Vista by methane recovery for fueling power generation.

Natural Gas

SDG&E also provides natural gas service in Chula Vista. There is no wellhead natural gas produced in San Diego County; all of SDG&E's supplies are purchased from out-of-region sources and piped into the County. Estimates of CO₂ from pipeline flaring (and equivalent units of methane venting associated with pipeline operation), including deliveries to power plants and direct-use consumers, totals about 146,000 tons/yr. As with previous estimates, this value is an approximation. Actual values were not available from SDG&E at the time of plan preparation.

Transportation Fuels

All petroleum transportation fuels used in Chula Vista are produced and refined outside of the region. Most gasoline and diesel supplies are refined at facilities in the Los Angeles area, and either piped or shipped by truck or rail into San Diego County. For the purposes of emission calculations for this section, staff only included emissions that the city has direct control over. Because freeway traffic does not originate or end with Chula Vista residents, the City cannot greatly effect a reduction in those emissions. Thus freeway traffic on I-5 and I-805 through the City was not included in the calculations because the city has no direct relationship with those individuals driving north to south that do not live in Chula Vista. Staff did include trips originating in Chula Vista, trips ending in Chula Vista, and internal trips. Incorporating all freeway traffic (including through-put traffic) would increase the total, but there would be no way to effect reductions. Therefore, emissions are based upon traffic moving 1) within Chula Vista, 2) originating from Chula Vista, or 3) ending in Chula Vista, approximately 89,000 tons of CO₂ emissions per year is estimated for Chula Vista's share of petroleum refining and distribution.

Summary

The 1990 inventory of consumption and production emissions is summarized by end-use sector and fuel type in Table 2.1. Figures 2.1 and 2.2 provide graphic illustrations of the data contained in Table 2.1, including energy consumption and CO₂ emissions by end-use sector in Figure 2.1, and energy consumption and CO₂ emissions by fuel type in Figure 2.2. The inventory is also fully detailed in Appendices A and B. In total, Chula Vista emits about one million tons of CO₂ annually. About half of

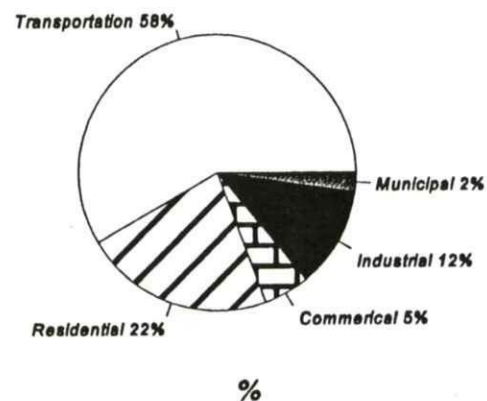
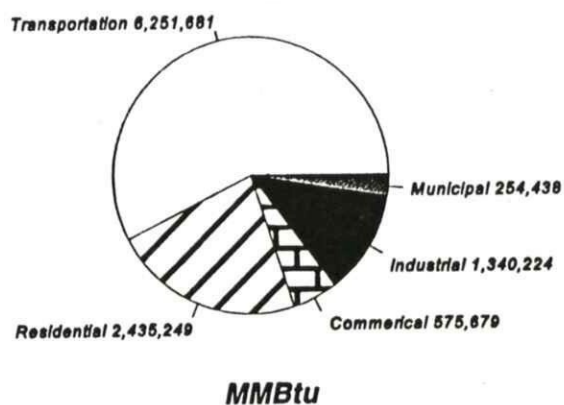
Table 2.1
1990 TOTAL ENERGY CONSUMPTION AND CO₂ EMISSIONS

End-Use Sector	Fuel Type	Energy Consumption		CO ₂ Emissions		
		MMBtu	%	Tons	% by Sector	Lbs Per Capita
Residential	Electricity	794,378	33	144,563	58	2,140
	Natural Gas	1,640,871	67	103,273	42	1,528
	Gasoline	0.00	0.00	0.00	0.00	0.00
	Diesel	0.00	0.00	0.00	0.00	0.00
	Propane	0.00	0.00	0.00	0.00	0.00
	Sub-total	2,435,249	100	247,836	100	3,668
Commercial	Electricity	182,933	32	33,291	57	493
	Natural Gas	392,746	68	24,720	43	366
	Gasoline	0.00	0.00	0.00	0.00	0.00
	Diesel	0.00	0.00	0.00	0.00	0.00
	Propane	0.00	0.00	0.00	0.00	0.00
	Sub-total	575,679	100	58,011	100	859
Industrial	Electricity	610,099	46	111,027	71	1,643
	Natural Gas	730,125	54	45,956	29	680
	Gasoline	0.00	0.00	0.00	0.00	0.00
	Diesel	0.00	0.00	0.00	0.00	0.00
	Propane	0.00	0.00	0.00	0.00	0.00
	Sub-total	1,340,224	100	156,983	100	2,323
Municipal	Electricity	176,782	70	32,171	83	476
	Natural Gas	13,883	5	874	2	13
	Gasoline	23,266	9	2,094	5	31
	Diesel	40,508	16	3,936	10	58
	Propane	0.00	0.00	0.00	0.00	0.00
	Sub-total	254,439	100	39,075	100	578
Transportation	Electricity	1,486	0.00	0.00	0.00	0.00
	Natural Gas	100	0.00	0.00	0.00	0.00
	Gasoline	5,734,119	91	514,103	91	7,609
	Diesel	556,126	9	50,098	9	741
	Propane	25,208	0.00	2,180	0.00	33
	Sub-total	6,317,039 ^(a)	100	566,381	100	8,383
	Total	10,922,630		1,068,286		15,811

(a) Includes municipal transportation fuel.

Figure 2.1

**1990 TOTAL
ENERGY CONSUMPTION BY END-USE SECTOR**



**1990 TOTAL
CO2 EMISSIONS BY END-USE SECTOR**

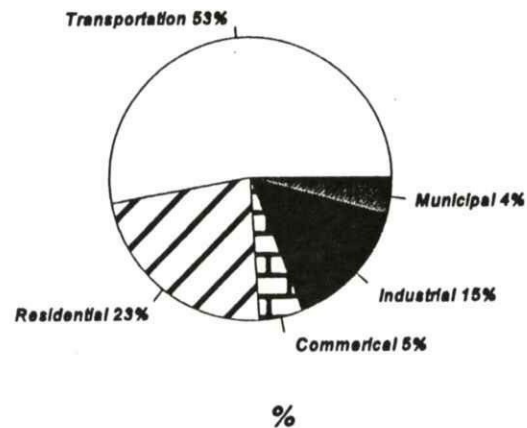
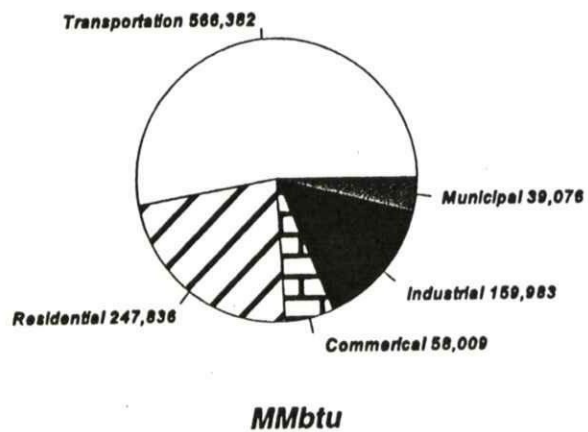
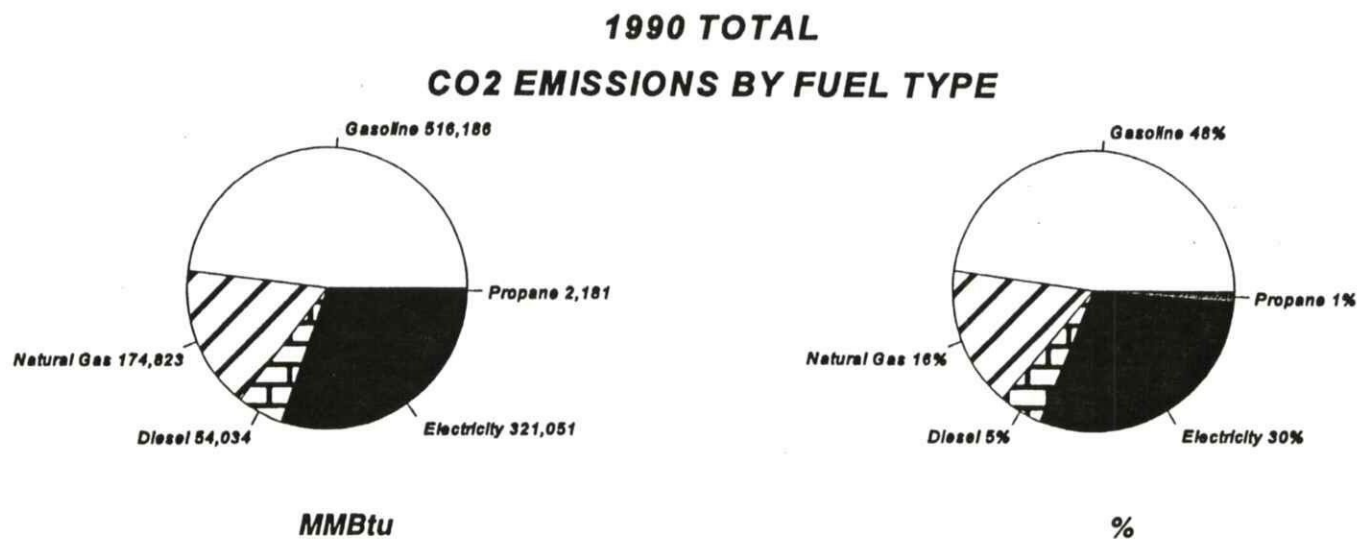
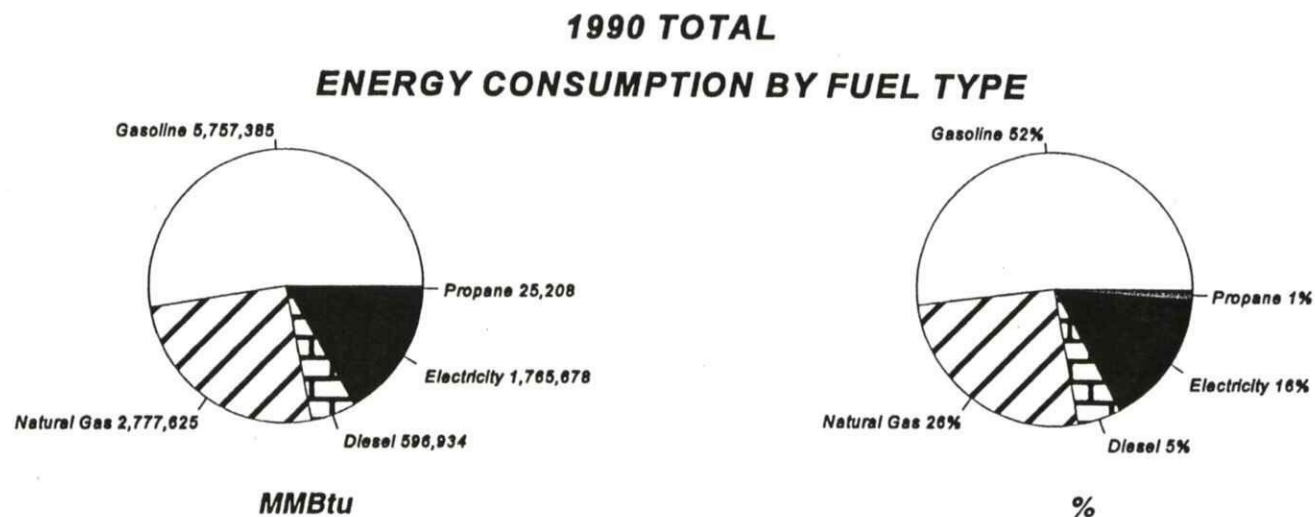


Figure 2.2



the emissions come from the transportation sector, one-quarter come from residences, and the remaining quarter is split between the commercial, industrial, and municipal sectors. Of the fuels used by these sectors, gasoline accounts for nearly half of the CO₂ emissions, and about one-third come from electricity. The remaining 20% is split between natural gas, propane, and diesel.

Figure 2.3 summarizes these emissions on a variety of personal and community levels in order to illustrate the relative magnitude of different end-use contributions to global warming.

Chula Vista conditions are compared to other ICLEI cities in Figure 2.4. Chula Vista appears to compare favorably with these cities in terms of lower per capita CO₂ emissions, but it should be remembered that Chula Vista is much smaller in population than other ICLEI cities, and as a rule energy intensities per capita are markedly greater in cities larger than 250,000 persons.

Chula Vista's per capita CO₂ emissions also compare favorably to other North American cities because of the relatively low carbon intensity of SDG&E's resource mix. Several of the other cities rely on coal and oil-fired power generation versus the natural gas, nuclear, and hydro characteristics of SDG&E's resource mix. Alternatively, Chula Vista does not compare favorably to European cities that are less reliant upon automobile travel.

Figure 2.3
EXAMPLES OF CHULA VISTA CO₂ EMISSIONS
(1990)

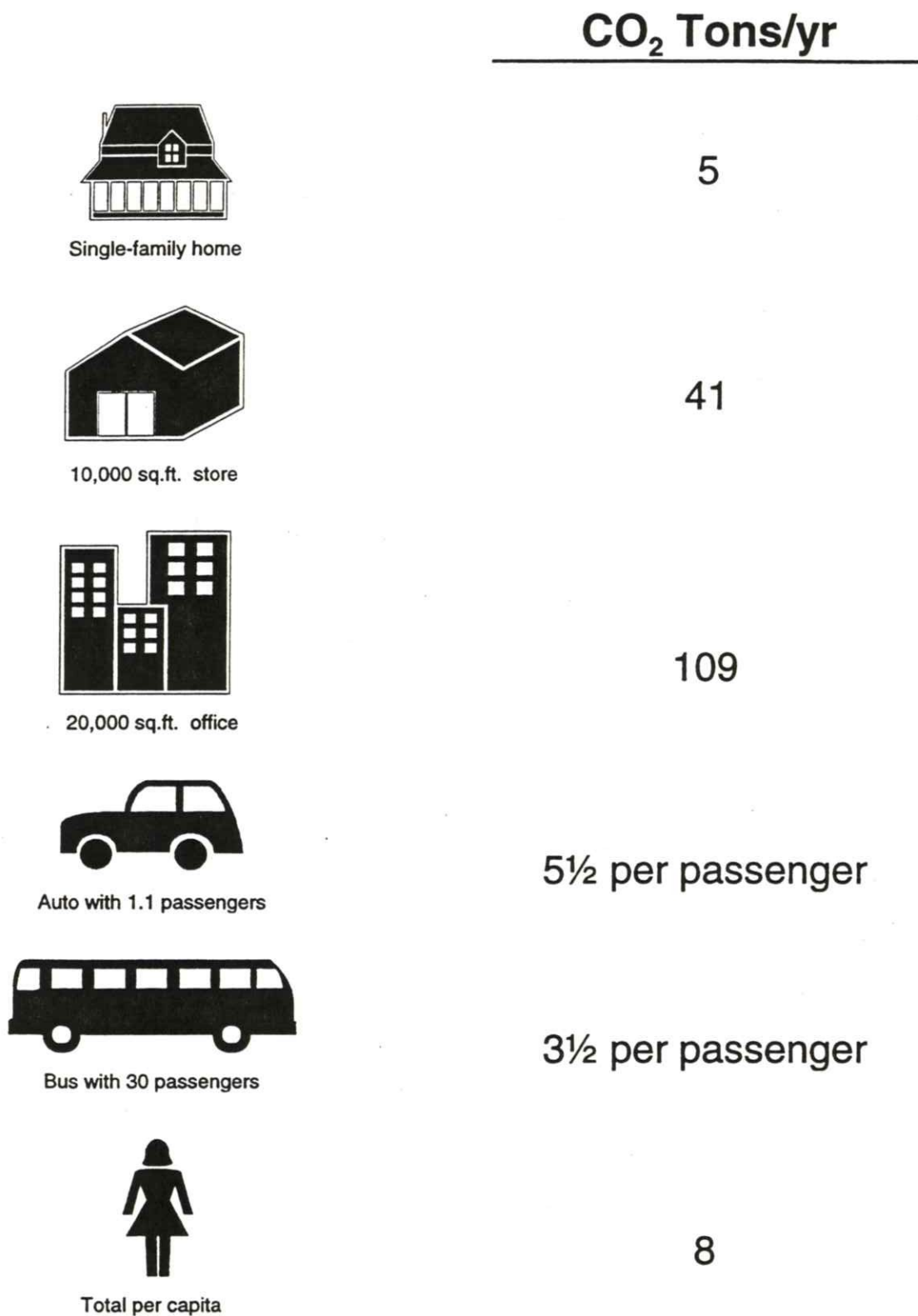
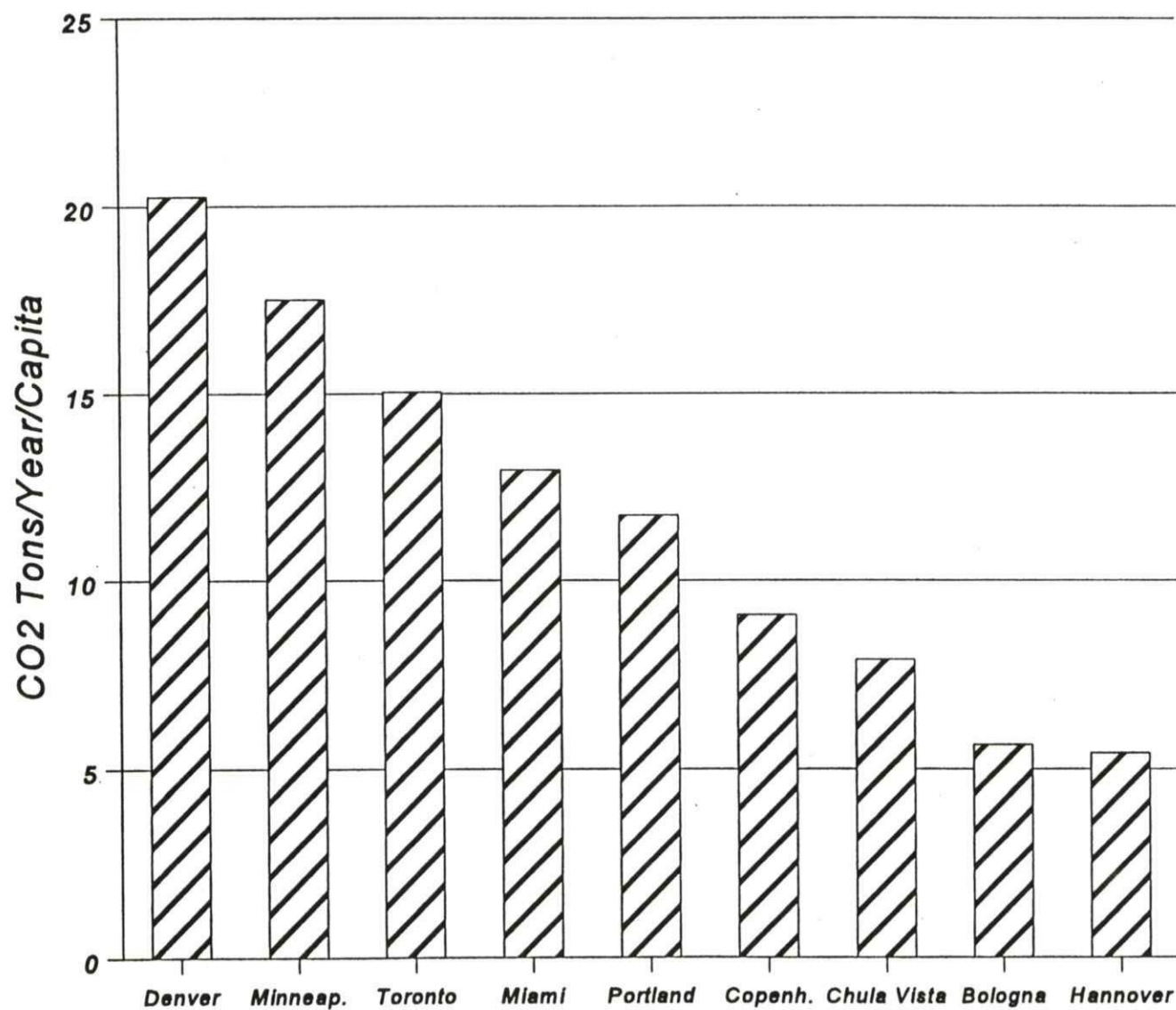


Figure 2.4
1990 PER CAPITA CO₂ EMISSIONS OF SELECTED ICLEI CITIES



3. EMISSIONS FORECAST



2010 EMISSIONS FORECAST

Having established a baseline inventory of Chula Vista's current CO₂ emissions, the next step in the planning process is a forecast of emissions growth under various future conditions. The purpose of such forecasting is to:

- Illustrate the increased global warming that may be caused by Chula Vista's population growth if CO₂ emission reduction actions are not taken.
- Identify the amount of CO₂ that reduction actions must eliminate in order for Chula Vista to stabilize or possibly reverse its global warming contributions.

The year 2010 is used as a planning horizon consistent with the international CO₂ reduction goal of 80% of 1990 levels in 2010. A set of forecasts have been prepared to simulate differing combinations of community variables that affect emissions, including:

- Population growth as projected by SANDAG Series VII population study for the current incorporated area. This study indicated that by 2010, Chula Vista is expected to grow 23%, adding 32,000 additional residents between 1990-2010. As the City continues to expand its territorial limits, and population expands, the potential CO₂ emissions and savings from the action measures will also increase. This estimate does not include the Otay Ranch area.
- Vehicle miles traveled (VMT) and transit passenger miles traveled as projected by SANDAG. These include all trip origins and destinations inside and outside the City consistent with the 1990 baseline inventory. VMT is increasing at a faster rate than population growth throughout California, and in Chula Vista a significant 44% increase is projected by 2010.
- The average fuel efficiency of vehicles on the road, which is presently 18 mpg in the San Diego region. This variable is influenced by federal fuel efficiency standards for new vehicles and the overall age of the region's vehicle stock. A gradual improvement in baseline fuel efficiency is assumed consistent with CEC projections that reach 21 mpg in 2010.

- The marginal electric generation CO₂ coefficient, or CO₂ intensity of incremental additions to SDG&E's resource mix in the future. This is influenced by the carbon intensity of fuels used in the future to generate the community's electricity, i.e., renewables versus fossil fuels. A gradual reduction in the baseline CO₂ intensity of SDG&E's electric fuel mix is assumed consistent with industry and regulatory trends. However, given the significant changes expected from electric industry restructuring, it is unclear how CO₂ emissions will be impacted. This is an issue, consistent with the City's legislative agenda, that the City will continue to monitor.

The forecasts are shown in Table 3.1 and Figure 3.1 according to four cases: 1) population and VMT growth only; 2) population and VMT growth with less carbon-intensive electric generation fuels; 3) population and VMT growth with vehicle fuel efficiency improvements that exceed the baseline trend; and 4) a combination of all three previous cases. All four forecasts represent scenarios of what could happen without any special municipal action to reduce Chula Vista's CO₂ emissions. Table 3.2 details the assumptions used for the improved electric resource mix scenario. All forecasts include projected methane emissions expressed in equivalent CO₂ units.

As a final step in projecting emissions, the average of the four "no municipal action" forecasts has been used in Figure 3.2 as a basis for comparison to the federal and international reduction goals as follows:

- Expected CO₂ emissions if Chula Vista takes no municipal action to reduce its emissions. The average of the four cases equates to 1,405,650 tons/yr of emissions in 2010.
- CO₂ emissions that would occur if Chula Vista achieves the current federal reduction goal of stabilizing emissions at 1990 levels. This would equate to 1,213,579 tons/yr of emissions in 2010, which would require a reduction of 192,071 tons/year ($1,405,650 - 1,213,579 = 192,071$).
- CO₂ emissions that would occur if Chula Vista achieves the international goal of 2010 emissions equaling 80% of 1990 levels. This would equate to 970,863 tons/yr of emissions in 2010, which would require a reduction of 434,787 tons/year ($1,405,650 - 970,863 = 434,787$).

Figure 3.3 expresses the forecasts in terms of CO₂ savings that must be achieved to reach either the federal or international goals. It should be noted again that electricity-related emission estimates in Tables 3.1 and 3.2, and Figures 3.1 through 3.3, are based on previous SDG&E resource planning which may be impacted by the electric industry restructuring currently underway.

3. Emissions Forecast

Table 3.1
2010 EMISSIONS FORECASTS WITHOUT MUNICIPAL ACTION
 (based upon SANDAG Series 7 population study¹ - does not include Rancho San Miguel, Otay Ranch)
 (CO₂ and CH₄)

	1990	2000	% Change from 1990	2010	% Change from 1990
Case A: Population and VMT Growth Only					
Population	135,136	151,412	12.04	166,688	23.35
Vehicle miles traveled/year	1,041,083,750	1,273,323,100	22.31	1,505,562,450	44.61
Transit passenger miles traveled/year	59,787,953	73,125,127	22.31	86,462,301	44.61
Marginal elec. CO ₂ coef. (lbs/kWh)	1.24	1.24	0.00	1.24	0.00
Vehicle fuel efficiency (mpg)	18	19	5.56	21	16.67
No action (CO ₂ tons)	1,213,579	1,381,414	13.83	1,499,489	23.56
Federal reduction goal: 2000 = 1990 (CO ₂ tons)		1,213,579	0.00	1,213,579	0.00
ICLEI reduction goal: 2010 = 80% of 1990 (CO ₂ tons)		1,092,221	-10.00	970,863	-20.00
Case B²: Case A Plus Electric Resource Mix Improvement					
Population	135,136	151,412	12.04	166,688	23.35
Vehicle miles traveled/year	1,041,083,750	1,273,323,100	22.31	1,505,562,450	44.61
Transit passenger miles traveled/year	59,787,953	73,125,127	22.31	86,462,301	44.61
Marginal elec. CO ₂ coef. (lbs/kWh)	1.24	1.10	-11.47	1.00	-19.52
Vehicle fuel efficiency (mpg)	18	19	5.56	21	16.67
No action (CO ₂ tons)	1,213,579	1,298,249	6.98	1,343,683	10.72
Federal reduction goal: 2000 = 1990 (CO ₂ tons)		1,213,579	0.00	1,213,579	0.00
ICLEI reduction goal: 2010 = 80% of 1990 (CO ₂ tons)		1,092,221	-10.00	970,863	-20.00
Case C: Case A Plus Vehicle Efficiency Improvement					
Population	135,136	151,412	12.04	166,688	23.35
Vehicle miles traveled/year	1,041,083,750	1,273,323,100	22.31	1,505,562,450	44.61
Transit passenger miles traveled/year	59,787,953	73,125,127	22.31	86,462,301	44.61
Marginal elec. CO ₂ coef. (lbs/kWh)	1.24	1.24	0.00	1.24	0.00
Vehicle fuel efficiency (mpg)	18	20	11.11	22	22.22
No action (CO ₂ tons)	1,213,579	1	11.13	1,467,617	20.93
Federal reduction goal: 2000 = 1990 (CO ₂ tons)		1,213,579	0.00	1,213,579	0.00
ICLEI reduction goal: 2010 = 80% of 1990 (CO ₂ tons)		1,092,221	-10.00	970,863	-20.00
Case D: Cases A/B/C Combined					

¹The population estimates are based upon SANDAG Series VII for the current incorporated area. As the City continues to expand its territorial limits, and population expands, the potential CO₂ emissions and potential savings from the action measures will also increase. The previous estimated savings of 100,000 tons/yr of CO₂ emissions could increase to 150,000 to 160,000 tons based on application to expanded territory of the twenty action measures when fully implemented. These measures will offset population impacts.

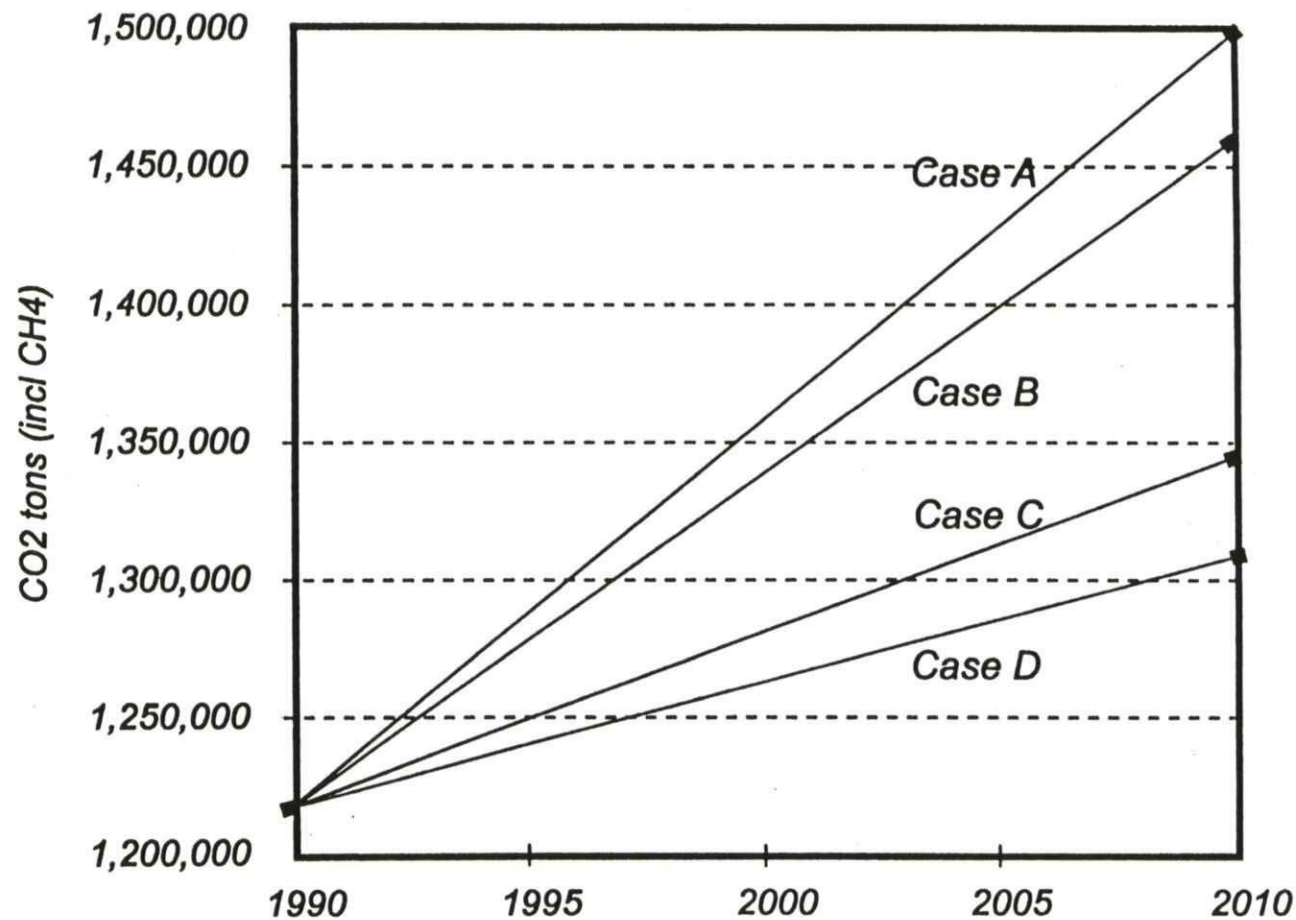
²Due to utility restructuring and deregulation plans, the Case B scenario is no longer valid, according to SDG&E, the PUC and CEC. Because this inventory was done prior to the PUC's decision in 1995 to restructure the utility industry, resource mix improvements will not be pursued at this time by the local utility.

3. Emissions Forecast

Table 3.1 Continued

	1990	2000	% Change from 1990	2010	% Change from 1990
Population	135,136	151,412	12.04	166,688	23.35
Vehicle miles traveled/year	1,041,083,750	1,273,323,100	22.31	1,505,562,450	44.61
Transit passenger miles traveled/year	59,787,953	73,125,127	22.31	86,462,301	44.61
Marginal elec. CO ₂ coef. (lbs/KWh)	1.24	1.10	-11.47	1.00	-19.52
Vehicle fuel efficiency (mpg)	18	20	11	22	22
No action (CO ₂ tons)	1,213,579	1,265,435	4.27	1,311,811	8.09
Federal reduction goal: 2000 = 1990 (CO ₂ tons)		1,213,579	0.00	1,213,579	0.00
ICLEI reduction goal: 2010 = 80% of 1990 (CO ₂ tons)		1,092,221	-10.00	970,863	-20.00

Figure 3.1
2010 CO₂ FORECASTS WITHOUT MUNICIPAL ACTIONS



- Case:
- A: Population and VMT growth only.
 - B: Projected electric resource mix improvement. *Due to State of California utility deregulation and restructuring plans, the Case B scenario characterized in this report is no longer valid, according to SDGE, the PUC and CEC. Resource improvement plans is uncertain at this time. Thus Case B is no longer valid.*
 - C: Vehicle efficiency improvement.
 - D: Electric resource mix and vehicle efficiency improvements.

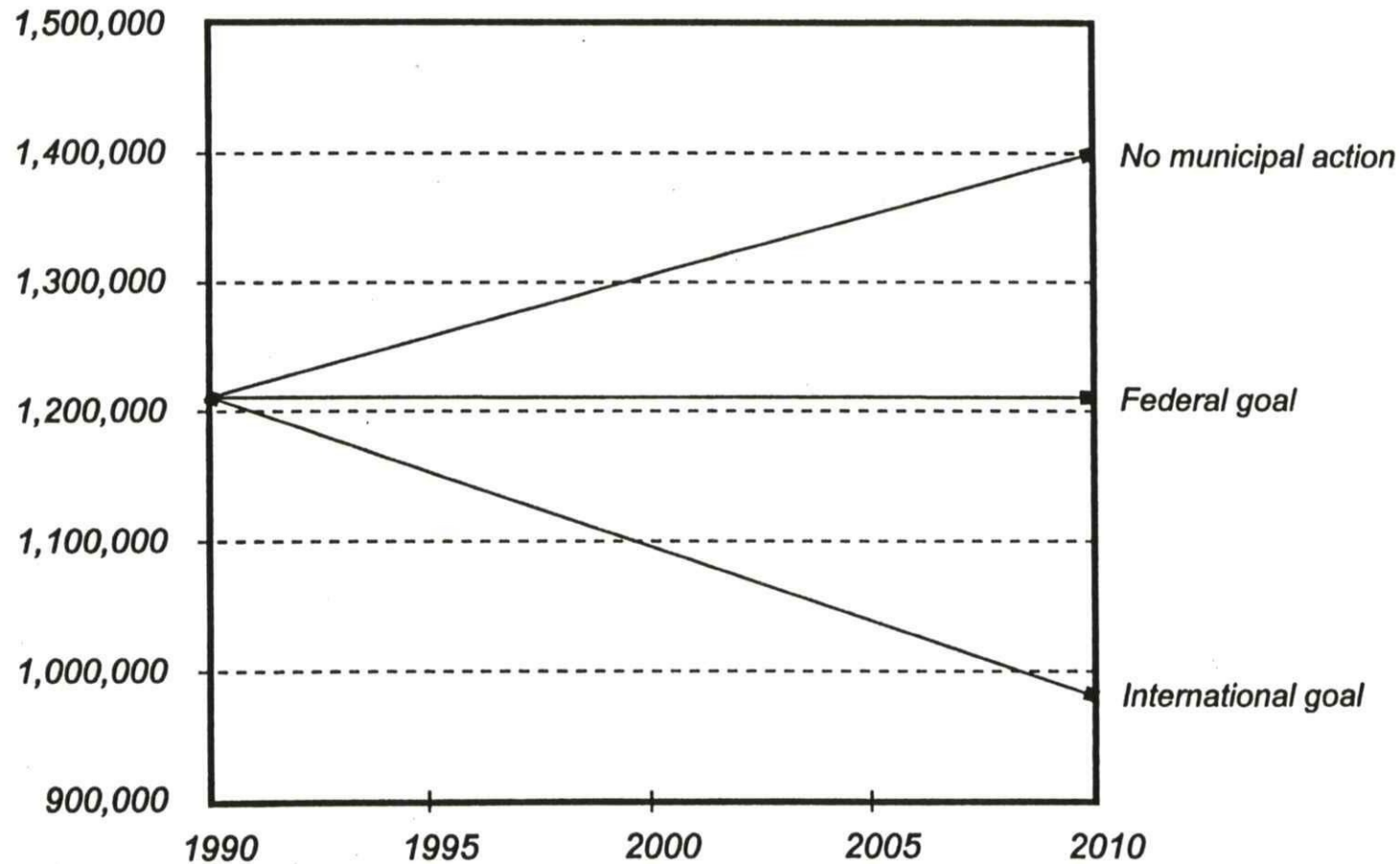
Table 3.2
**TOTAL SDG&E ELECTRIC GENERATION RESOURCE MIX:
 1990 BASELINE AND 2010 SCENARIO³**

Fuel Type	Case A: 1990 Baseline		Case B: 2010 Improved Mix	
	% Total MWh	CO₂ Lbs/KWh	% Total MWh	CO₂ Lbs/KWh
<i>Nuclear</i>	23.30	0.0000	20.00	0.0000
<i>Natural Gas</i>	36.85	0.5803	47.20	0.7432
<i>Fuel Oil</i>	3.86	0.0887	0.00	0.0000
<i>Coal</i>	19.87	0.5697	9.00	0.2580
<i>Biomass</i>	0.02	0.0006	0.00	0.0000
<i>Biogas</i>	0.20	0.0032	0.30	0.0047
<i>Hydro</i>	7.70	0.0000	7.50	0.0000
<i>Geothermal</i>	8.20	0.0000	9.00	0.0000
<i>Solar</i>	0.00	0.0000	4.00	0.0000
<i>Wind</i>	0.00	0.0000	2.00	0.0000
<i>Ocean</i>	0.00	0.0000	0.50	0.0000
<i>System Efficiency Improvements</i>	0.00	0.0000	0.50	0.0000
Total	100.00	1.2425	100.00	1.0059

Figure 3.2

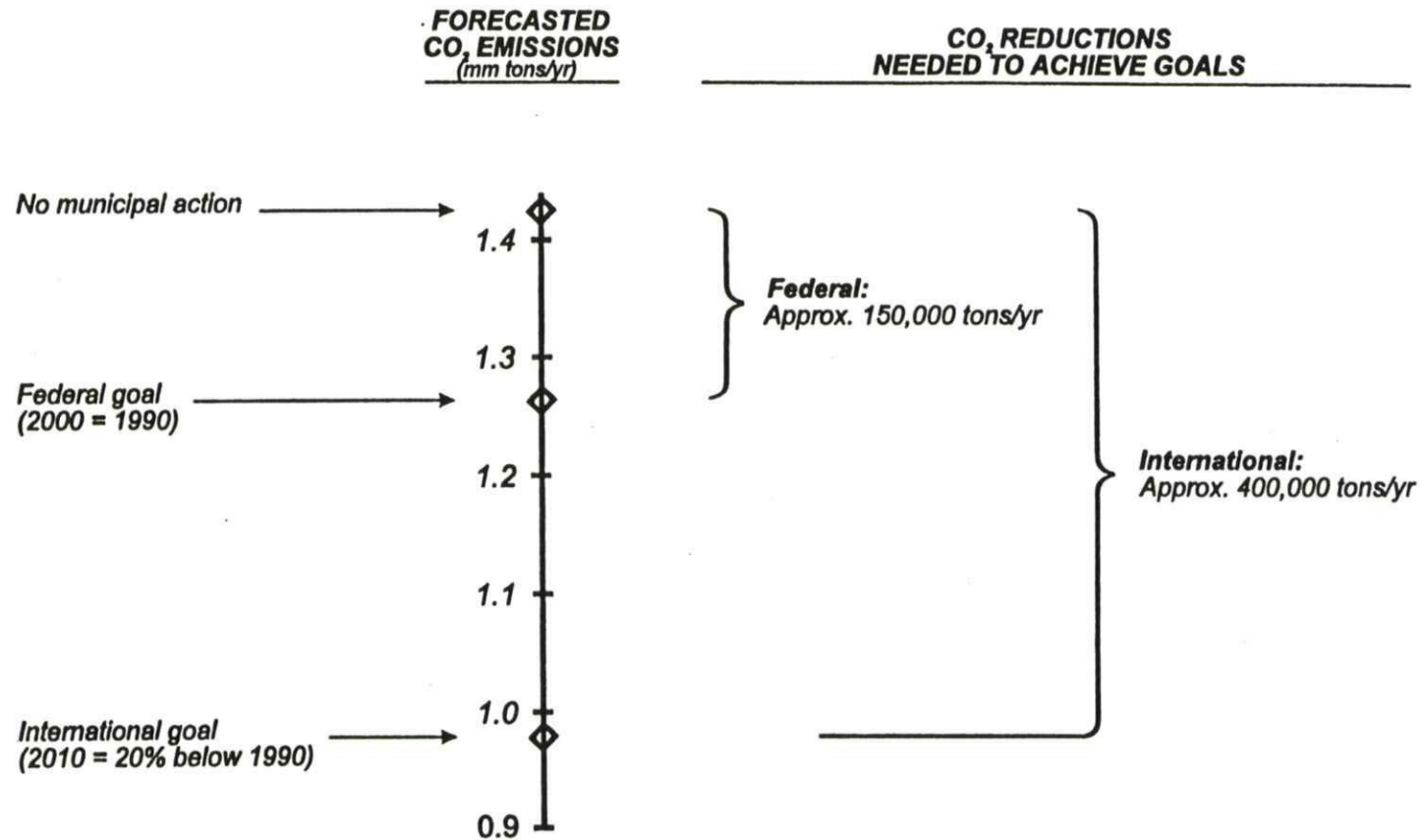
³Again, due to State of California utility restructuring plans, resource mix improvements characterized in this report are no longer valid. SDG&E's resource improvement plans have been placed on hold.

Figure 3.2
**2010 NO ACTION FORECAST COMPARED TO FEDERAL
AND INTERNATIONAL REDUCTION GOALS**



Federal goal: 2000 = 1990
International goal: 2010 = 80% of 1990

Figure 3.3
SUMMARY OF ALTERNATIVE REDUCTION GOALS



4. REDUCTION STRATEGY



CO₂ EMISSION REDUCTION STRATEGY

Emission Reduction Measures

Having established baseline and future CO₂ emission estimates, the next planning step is an evaluation of CO₂ reduction measures suitable for Chula Vista, how much CO₂ they could save, and how they can be assembled into an effective reduction strategy. For purposes of developing the strategy, emission reduction measures are grouped into the following seven categories:

- Transportation control
- Land-use
- Clean transportation fuels
- Residential/commercial/industrial buildings
- Municipal government
- Electricity and natural gas supply systems
- Regional/state/federal policies

Using these groups of measures, the reduction strategy was formulated in the following manner:

1. The consultant provided a total potential universe of approximately 300 reduction measures compiled from regional, state, national, and international sources.
2. The consultant conducted an initial screening of 300 measures and presented the Task Force with a generic list of 168 "CO₂ Reduction Measure Descriptions" for screening by the Task Force with regard to applicability to Chula Vista and favorable economics. The Task Force reviewed the generic measure descriptions as they were presented in five categories: transportation control; land use; building measures; alternative fuels, municipal measures.
3. The Task Force then reviewed all 168 reduction measures in detail to establish their Chula Vista suitability. Many were eliminated by the Task Force during the screening process. The screening process identified 90 preferred measures using the evaluation criteria in Table 4.1.

Table 4.1
CO₂ REDUCTION MEASURE SELECTION CRITERIA

Preferred Measures

- Overall appropriateness of the measure to Chula Vista's geography and character.
- General acceptability of the measure to the public.
- Acceptability of the measure's technology requirements, if applicable.
- Feasibility of implementation funding.
- Presence of an established and/or growing market for the measure.
- Ability to quantifiably gauge results and benefits.
- Useful life or durability of a measure's CO₂ savings.
- Availability of an organization willing and capable to implement a measure.

Action Measures

- Measures already underway.
- Diversity of measures.
- Magnitude of CO₂ savings.
- Cost-effectiveness.
- Measurable results.
- Adequate implementation resources.

4. Of the 90 preferred measures, the Task Force then selected 20 “action” measures for implementation following plan adoption. Selection criteria for these 20 measures are also given in Table 4.1.

The remainder of this chapter describes the seven categories of measures in more detail, and summarizes the Task Force’s review that lead to the selection of preferred and action measures.

Transportation Control Measures

Transportation control measures (TCMs) are those CO₂ reduction actions that reduce auto dependence and/or increase the efficiency of vehicle use. For example, TCMs include actions that reduce or eliminate auto trips, or that increase auto occupancy levels. TCMs do not include fuel changes; these are addressed in a following section on Clean Fuels.

The Task Force conducted a detailed review of all TCMs in the SANDAG regional TCM plan, as well as numerous TCMs from other jurisdictions, and several suggested by Task Force members. In total, about 75 TCMs were evaluated against the criteria in Table 4.1 in order to arrive at preferred and action measures. TCMs preferred by the Task Force are listed below according to those suitable for direct municipal action, and those requiring implementation by other organizations that can be encouraged by the municipality:

Direct Municipal Action Measures

- Transit
 - ☐ Route improvements
 - ☐ Terminal/stop improvements

- Parking management
 - ☐ Parking cash-out
 - ☐ High Occupancy Vehicle preferential parking
 - ☐ Limit new parking in areas with transit
 - ☐ Improved enforcement
 - ☐ Bus stop relocation to parking areas

- Employment travel
 - Telecommuting and telecenters
- Shopper shuttle
 - Shopper shuttle service
- Ridesharing
 - Transportation management associations
 - Vanpool programs
 - Carpool matching programs
 - Guaranteed ride home
- Information distribution
 - Ridesharing/park and ride signage
 - Ridesharing matching programs
 - Transit/paratransit promotion
 - Traffic condition announcements/signs
- Pedestrian travel
 - Safety improvement
 - Direct connections with transit
- Bicycle travel
 - Education and promotion
 - Integration at employment/shopping areas
 - Bikeways/lanes
 - Integration with transit
 - Incentives for showers/clothing lockers at employment locations
- Roadway assignment
 - Reversible-flow bus and car lanes

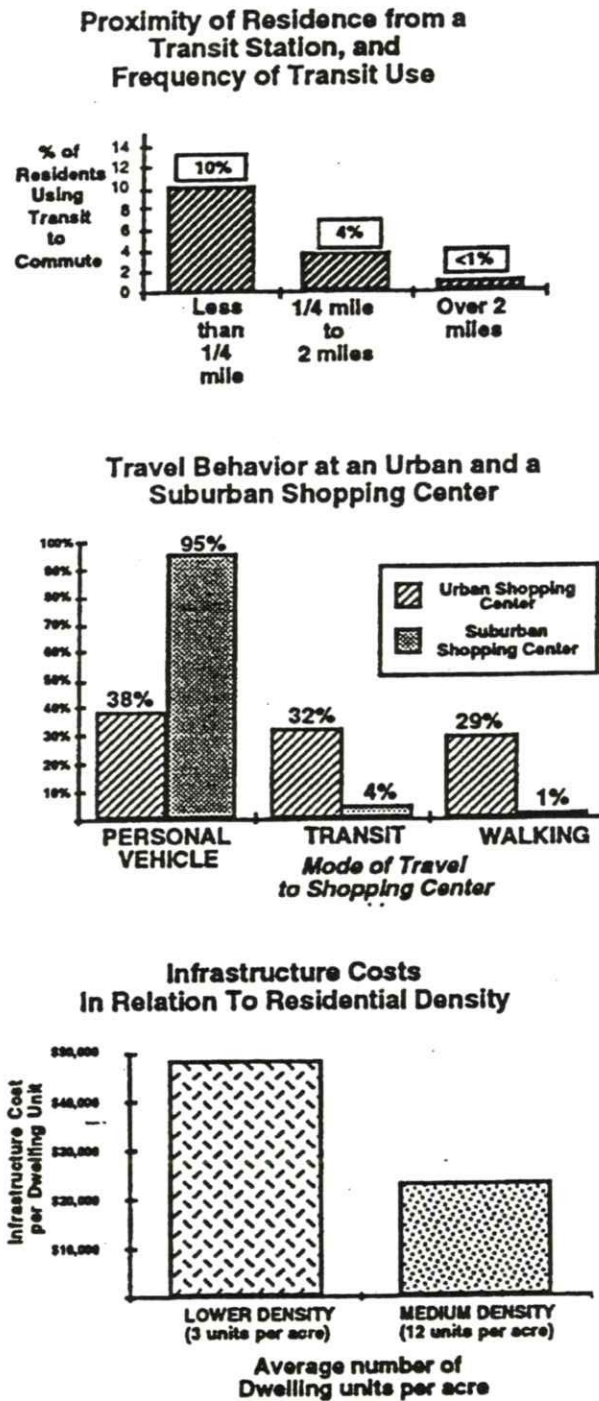
Other Measures to be Advocated

- Transit
 - ☐ Commuter discounts
 - ☐ Peak/off-peak transit fares
- Parking management
 - ☐ Parking cash-out
 - ☐ Parking cost increases
- Employment travel
 - ☐ Four-day work week
 - ☐ Employment benefits based on HOV/transit use
 - ☐ Tax incentives for vanpool or transit
 - ☐ Parking disincentives for single occupancy vehicles
- Student travel
 - ☐ Parking/carpool incentives
 - ☐ Student transit subsidy
 - ☐ School mandated cost recovery
 - ☐ Reduced minimum distance for bus riders
- Pricing
 - ☐ Merchant transportation incentives for shoppers
 - ☐ Lower rates/preferential treatment for HOVs

Land-Use

Land-use CO₂ measures are those that reduce auto dependence and increase building energy efficiency through land-use mixes, densities, and siting standards that reduce energy consumption and promote non-auto travel modes. In effect, the shape and content of Chula Vista's land-use plan largely dictates the types and amount of energy needed for the community to function. By purposely shaping its land-uses to be more energy efficient, the community reduces pollutant and global warming emissions, and saves the costs of the fuels that create those emissions. These and other benefits such as reduced infrastructure costs are illustrated in Figure 4.1.

Figure 4.1
EFFECTS OF LAND-USE CO₂ REDUCTION MEASURES



Source: Air Resources Board, 1994.

The CO₂ implications of Chula Vista's general plan were recently evaluated as part of SANDAG's regional energy planning and growth management processes. Using SANDAG's geographic information system, and an energy planning methodology known as PLACE³S, the energy efficiency of Chula Vista land-use designations to 2010 were evaluated. The results, shown in Figure 4.2, are displayed in two steps: 1) potential efficiencies if land-uses were to take maximum advantage of their locational attributes, e.g., proximity to transit; and 2) net efficiencies given land-uses as actually planned. Figure 4.2 reveals the following conditions:

- Potential Efficiencies

Much of the older, western portion of Chula Vista is rated "very good" because of its higher densities, greater mix, and better pedestrian and transit orientation. Potential efficiencies fall to "fair" in the eastern portion of the community as land-use becomes primarily low-density single-family residential. This efficiency reduction (and CO₂ increase) occurs because of the auto dependence created by single-use, low-density development patterns. Such patterns also increase building and infrastructure energy use, and CO₂ emissions, even further.

- Net Efficiencies

Interestingly, when net efficiencies are determined by comparing planned land-uses with locational potentials, the east/west ratings are inverted. Much of the eastern portion is raised to a "good" rating because planned land-uses at least limit the amount of population growth at the urban fringe through low-density designations. Unfortunately, the western core of the community is downgraded from "high" to "moderate" efficiency because its planned land-uses do not take maximum advantage of their locational values, such as creating high-density areas close to transit and shopping. But steps are being taken to correct this problem, such as the case with the "Broadway Business Homes" development project that aims to create and enhance mix use and take advantage of higher densities.

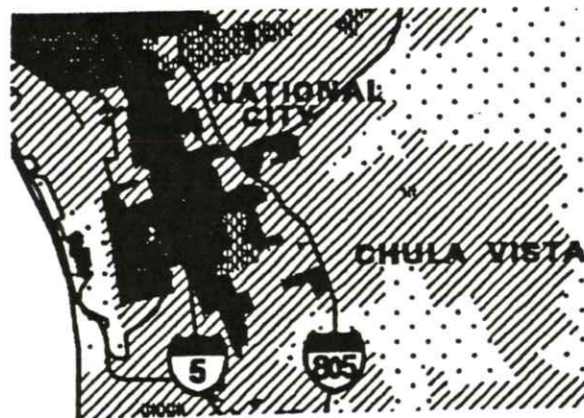
This PLACE³S evaluation points up the opportunity to reduce emissions with land-use designations and transportation improvements that match the capacity of Chula Vista's built environment. Figure 4.3 is a simplified illustration of the contrast in built form on either side of Interstate 805, with the west side favored by an integrated grid of streets and small lots patterns compared to the east side where street connectivity falls off rapidly, making the auto the dominant mode of travel. The major opportunity ahead for Chula Vista is how CO₂ friendly the SR125 corridor will be once it is developed.

Figure 4.2
PROJECTED LAND-USE EFFICIENCIES IN 2010
(SANDAG RGMS Existing Policies)

**Potential Efficiencies with
Maximized Land-Use**

Subarea Potential*

- High (Near Rail Center)
- High (Near Bus Center)
- ▨ Moderate
- ▤ Low



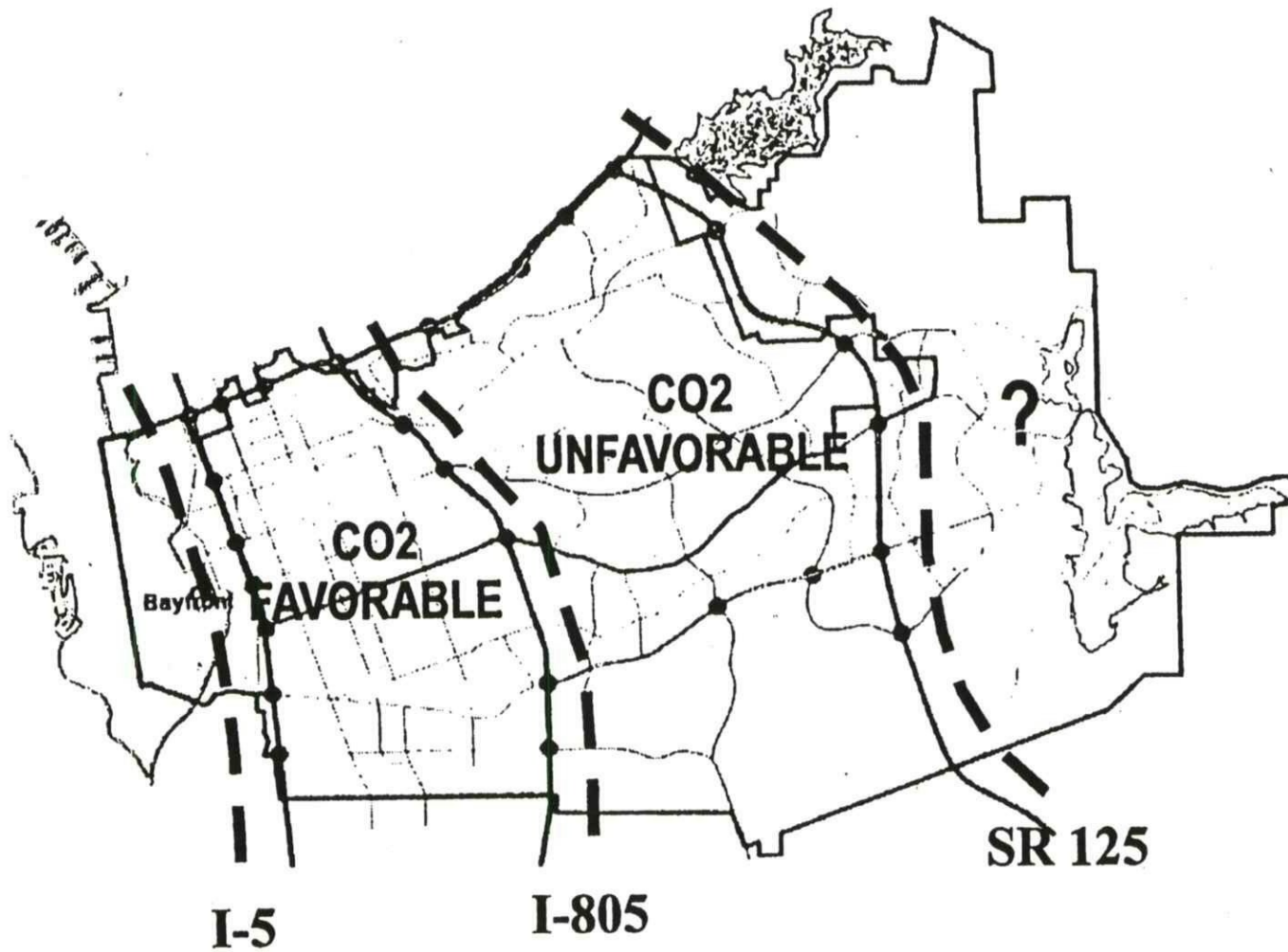
**Net Efficiencies with
Planned Land-Uses**

Energy Efficiency*

- Very Good
- Good
- ▨ Fair
- ▤ Poor



Figure 4.3
CO₂ FRIENDLINESS OF THE BUILT ENVIRONMENT



Source: SANDAG, 1994.

The Task Force reviewed a variety of measures recommended by SANDAG, the California Air Resources Board, and others. Planning Department staff participated in this review, and commented on measure suitability, including, in some cases, partial implementation of some techniques already developed. Those land-use measures preferred by the Task Force include the following:

- Use mix
 - Increasing mix of residential and complementary nonresidential uses. For example, neighborhood grocery stores close to homes.
 - Increasing mix of residential types, e.g., detached and attached single-family dwellings in the same neighborhood.
 - Decentralized services at dispersed locations. Activity and shopping areas readily accessible from neighborhoods throughout the City.
- Housing density
 - Increasing housing density near transit (transit overlay zone).
 - Encourage infill housing that takes advantage of vacant, already-serviced land in developed areas.
- Site design and orientation
 - Traditional neighborhood development (TND) emphasizing pedestrian/transit connections.
 - Locate schools/parks for efficient access.
 - Pedestrian/bike orientation. Provide direct, short, convenient linkages for pedestrian and bicyclists.
 - Transit orientation. Provide direct, short, convenient linkages to transit.
 - Solar orientation for passive and/or active use for commercial.
 - Vegetative cooling via shading to reduce building space cooling requirements.
 - Light-colored exterior surfacing that reflects heat to reduce building space cooling demands.
 - Carbon-absorbing landscaping planted strategically for that purpose (rather than purely for shading).

■ Mobility

- ☐ Pedestrian oriented street design, including direct, short, convenient linkages.
- ☐ Integrated street networks (multi-modal streets with high connectivity).
- ☐ Revise minimum/appropriate parking requirements, including shared parking and disincentives for single-occupant autos.

As noted earlier, some of these measures have already been adopted to some extent by the City in its planning for new growth in the Sweetwater area and Eastern Territories. Several features have been incorporated into plans for Otay Ranch; a detailed review of CO₂ reduction measure applicability for Otay Ranch is given in Appendix C. Extension of these techniques throughout the City will maximize CO₂ benefits.

Clean Transportation Fuels

Clean transportation fuels is the category of CO₂ reduction measures that substitutes "clean" vehicle fuels for traditional petroleum products through vehicle engine conversion or new vehicle purchases. The City, the Chula Vista Elementary School District, and Southwestern College all currently have natural gas vehicles (NGV) in operation. As of September 1995, the City and Southwestern College both have NGVs in service, while the School District operates seven compressed natural gas (CNG) school buses. The U.S. Postal Service in Chula Vista has 112 CNG vehicles in service, and Metropolitan Transit Development Board will operate 51 CNG buses to serve Chula Vista and the South Bay corridor. A CNG fueling station, which is open to the public, was installed at the Chula Vista Elementary School District in 1993. The U.S. Postal Service has its own CNG fueling station which was installed in 1994. MTDB also has its own station which was completed in 1995. Likewise, the City will employ three hydrogen fuel cell powered zero emission buses in its transit system in 1997-98.

The California Air Resources Board (ARB) adopted low-emission vehicle regulations in September 1990. These regulations established four new categories of emission standards for passenger cars and light-duty trucks: Transitional Low-Emission Vehicle (TLEV), Low-Emission Vehicle (LEV), Ultra-Low-Emission Vehicle (ULEV) and Zero-Emission Vehicle (ZEV). The regulations established a progressively more stringent fleet average emission requirement for non-methane organic gases, which manufacturers can meet by producing any combination of TLEVs, LEVs, ULEVs and ZEVs. In addition to meeting the fleet average emission requirement, the seven largest manufacturers are required to produce and offer for sale in California ZEVs in amounts equal to two percent of their total vehicle sales

beginning with the 1998 model year, rising to five percent in the 2001 model year and ten percent in the 2003 model year.

The ARB staff conducted a series of public forums during 1995 to discuss all aspects of the ZEV program, including hybrid-electric vehicles, consumer marketability, infrastructure, fleet issues, technology, benefits and costs. The ARB staff also established a Battery Technology Advisory Panel to evaluate the status of batteries for the 1998 implementation of ZEVs. Based on information gathered through the public forums and the Battery Panel, the ARB is now proposing to amend the regulations to eliminate the percentage ZEV requirements for model years 1998 through 2002. The ten percent requirement for the 2003 model year would remain unchanged. This modification would allow auto manufacturers more time to develop and demonstrate ZEVs powered by advanced batteries and flexibility to determine the best time to introduce this new technology to the market. To encourage the early production of advanced ZEVs, the ARB is also proposing to add a provision to allow multiple credits for longer-range ZEVs produced prior to the 2003 model year. These ZEV credits could be applied to a manufacturer's 2003 and subsequent model year requirements. To ensure that no emission reductions are lost by suspending the ZEV requirements, the ARB is recommending that it enter into agreements with each of the seven auto manufacturers that are subject to the 1998 through 2002 model year percentage ZEV requirements. These agreements would formalize commitments by the auto manufacturers to achieve the air quality benefits of the percentage ZEV requirements, to continue investing in advanced batteries, to produce ZEVs powered by advanced batteries for demonstration purposes, and to ramp up to large-volume ZEV production in the 2003 model year.

The Federal Energy Policy Act (EPACT) of 1992 requires conversion of fleet vehicles to clean fuels according to the schedule given in Table 4.2. EPACT required federal fleets to begin purchasing alternate fuel vehicles in 1993. The Act requires state fleets and alternative fuels providers to begin purchasing alternative fuel vehicles in model year 1996. And the law may require private and municipal fleets to acquire alternative fuel vehicles starting as early as model year 1999. Under EPACT, the Secretary of Energy has two opportunities to mandate private and municipal fleet action as shown in Table 4.2. If a rule making is issued by December 15, 1996, then "early rule making" will apply; and if rule making is not issued until January 1, 2000, then "future rule making" will apply. If no rule making is issued by the later date, there will be no private or municipal fleet mandates.

Table 4.2
**EPACT CLEAN FUEL TIMETABLE
FOR PRIVATE AND MUNICIPAL FLEETS**

<i>Model Year</i>	<i>Early Rule Making Scenario</i>	<i>Future Rule Making Scenario</i>
<i>1999</i>	<i>20%</i>	<i>---</i>
<i>2000</i>	<i>20%</i>	<i>---</i>
<i>2001</i>	<i>20%</i>	<i>---</i>
<i>2002</i>	<i>30%</i>	<i>20%</i>
<i>2003</i>	<i>40%</i>	<i>40%</i>
<i>2004</i>	<i>50%</i>	<i>60%</i>
<i>2005</i>	<i>60%</i>	<i>70%</i>
<i>2006 on</i>	<i>70%</i>	<i>70%</i>

Source: Federal Energy Policy Act

In considering clean fuels, Chula Vista has three choices in the near term based on the current commercialization of alternative fuels and their supporting technologies:

- Electricity
- Compressed natural gas (CNG)
- Methanol

There are other emerging fuel options, such as hydrogen, clean diesel, and biodiesel. The timing of their commercial status is uncertain at this point. The City should actively monitor emerging alternatives, such as hydrogen and clean diesel, while it focuses on commercialized alternatives in the near term. Implementation options for clean fuels include the purchase of new vehicles equipped to use them; the conversion of existing vehicles to use them; and the provision of new or modified fueling (or charging) infrastructure to support widespread clean fuel use. In the near-term, the most cost effective and emission-reducing opportunities exist in vehicle fleets operated by public and private organizations, where large numbers of vehicles are fueled and maintained by single owners at centralized locations.

Currently, the general public refueling network for clean fuels is also very limited. Key barriers that need to be eliminated, in part through local planning, have been identified by the CEC in its 1994 Calfuels plan as follows:

- All clean fuels
 - Lack of training for vehicle technicians and emergency personnel.
 - Need for increased public awareness of clean fuels and their benefits.
- Electric vehicles
 - Lack of standard charging equipment and connectors.
 - Need for code revisions and information dissemination.
- Natural gas vehicles
 - Limited fueling network.
 - Need for code revisions and information dissemination.

Preferred implementation measures within clean fuel market segments include the following:

- Fleet operator conversion/purchase commitments and phase-in schedules. For example, the City can exercise leadership by developing a municipal fleet that is 100% clean fueled or high conventional fuel efficient by 2010.
- Comprehensive municipal departmental review and removal of any code barriers to clean fuels commercialization. In particular, safety requirements should not create unnecessary obstacles to clean fuel commercialization while still maintaining adequate safety standards.
- Provide technical assistance and/or referral services for persons interested in conversion/purchase. Conversion assistance should include information on the importance of CARB-certified retrofit kits.
- Expansion of adult and/or college job training aimed at maintenance of clean fuel vehicles and fueling infrastructure.
- Preferential treatment of clean fueled vehicles, such as special parking privileges.
- Use of high visibility special applications, such as meter reading, to demonstrate clean fuel vehicles to the community at large.
- Recruitment of designers and parts manufacturers supplying components to the clean fuel industry, consistent with the Border Environmental Commerce Alliance and Boarder Environmental Technology Resource Center respectively.
- Awards program to recognize exemplary clean fuel efforts in the community.

Residential, Commercial, and Industrial Sectors

This category of CO₂ reduction measures consists of energy efficiency measures for building space conditioning, lighting, and process improvements. Measures have been organized as follows:

- Residential/commercial new construction
 - ☐ Space heating
 - ☐ Space cooling
 - ☐ Domestic hot water
 - ☐ Appliances
 - ☐ Pools and spas
 - ☐ Lighting
 - ☐ Office equipment

- Residential/commercial retrofit and remodeling
 - ☐ Space heating
 - ☐ Space cooling
 - ☐ Domestic hot water
 - ☐ Appliances
 - ☐ Pools and spas
 - ☐ Lighting
 - ☐ Office equipment

- Industrial retrofit and new construction
 - ☐ Space conditioning
 - ☐ Lighting
 - ☐ Ventilation
 - ☐ Motors

Since the 1970s, builders and consumers alike have demonstrated clear preferences for increased efficiency measures in these areas that are cost-effective. This is reflected in the growing market preference for efficient homes generally, and increasing consumer purchases of high-efficiency models of appliances. If builders and consumers are provided with good information on measures that are economically sound, experience has shown that the buying public will respond accordingly. In fact, there is strong evidence that builders and the public can be motivated as much by non-energy benefits as by direct energy savings. In mounting a voluntary implementation effort for building efficiency based on information and incentives the City should promote the types of non-energy benefits detailed in Appendix D in addition to energy and CO₂ savings.

The major thrust of a voluntary effort is increasing awareness of building efficiency benefits, including public cost savings, housing affordability improvements, business productivity increases, and reduced

resource consumption generally. These messages can be conveyed to the community using a variety of methods, including the following examples:

- Information dissemination

This can occur at the permit counter, vendor and material outlets, and professional meetings. Information can be distributed in printed and video form; with interactive learning software; and through a speakers bureau involving local professional organizations such as the American Institute of Architects and the American Society of Heating, Refrigeration, and Air Conditioning Engineers. Table 4.3 presents a checklist of building design and construction practices that an information program can be built around. Appendix D contains information on non-energy benefits that should also be stressed.

- Design assistance

Homeowners and designers should be able to obtain limited technical help, or access to self-help information, from sources such as the City's Web Page or other on-line services.

- Design competitions and awards

Exemplary efforts should be encouraged through annual efficiency competitions and well-publicized awards.

- Home efficiency rating system

One of the best voluntary approaches used in many parts of the country are home energy efficiency ratings that occur when a residence is built or sold. Austin, Texas has a successful "Greenstar" program, and California has a very successful non-profit statewide program called CHEERS (California Home Energy Efficiency Rating System). The City plans to establish a GreenStar Building program. Information is to be provided in the Department of Building and Housing.

SAMPLE CHECKLIST:

Table 4.3

ENERGY-EFFICIENT BUILDING DESIGN AND CONSTRUCTION CHECKLIST

DESIGN	
<i>Smaller is better.</i>	<i>Optimize use of interior space through careful design so that the overall building size--and resource use in constructing and operating it--are kept to a minimum.</i>
<i>Design an energy-efficient building.</i>	<i>Use high levels of insulation, high-performance windows, and tight construction. Choose glazings with low solar heat gain.</i>
<i>Design buildings to use renewable energy.</i>	<i>Passive solar heating, daylighting, and natural cooling can be incorporated cost-effectively into most buildings. Also consider solar water heating and photovoltaics--or design buildings for future panel installation.</i>
<i>Optimize material use.</i>	<i>Minimize waste by designing for standard sizes. Avoid waste from structural over-design (use optimum-value engineering/advanced framing).</i>
<i>Design water-efficient, low-maintenance landscaping.</i>	<i>Conventional lawns have a high impact because of water use, pesticide use, and pollution generated from mowing. Landscape with drought-resistant native plants and perennial groundcovers.</i>
<i>Make it easy for occupants to recycle waste.</i>	<i>Make provisions for storage and processing of recyclables: recycling bins near the kitchen, undersink door-mounted bucket with lid for compostable food waste, etc.</i>
<i>Design for future reuse.</i>	<i>Make the structure adaptable to other uses, and choose materials and components that can be reused or recycled.</i>
<i>Avoid potential health hazards: radon, EMF, pesticides.</i>	<i>Follow recommended practices to minimize radon entry into the building and provide for future mitigation if necessary. Plan electrical wiring and placement of electrical equipment to minimize electromagnetic field exposure. Design insect-resistant detailing that will require minimal use of pesticides.</i>
SITING	
<i>Renovate older buildings.</i>	<i>Conscientiously renovating existing buildings is the most sustainable construction.</i>
<i>Evaluate site resources.</i>	<i>Early in the siting process carry out a careful site evaluation: solar access, soils, vegetation, important natural areas, etc.</i>
<i>Locate buildings to minimize environmental impact.</i>	<i>Cluster buildings or build attached units to preserve open space and wildlife habitats, avoid especially sensitive areas including wetlands, and keep roads and service lines short. Leave the most pristine areas untouched, and look for areas that have been previously damaged to build on.</i>
<i>Pay attention to solar orientation.</i>	<i>Reduce energy use by orienting buildings to make optimal use of passive solar heating, daylighting, and natural cooling.</i>
<i>Situate buildings to benefit from vegetation.</i>	<i>Trees on the east and west sides of a building can dramatically reduce cooling loads. Hedge rows and shrubbery can block cold winter winds or help channel cool summer breezes into the building.</i>

4. Reduction Strategy

Table 4.3 Continued

MATERIALS	
Avoid ozone-depleting chemicals in mechanical equipment and insulation.	Chlorofluorocarbons (the main contributor to ozone and facilitator of global warming) have largely been phased out, but their primary replacements--Hydrofluorocarbons-- also damage the ozone layer and should be avoided where possible. Reclaim Chlorofluorocarbons when servicing or disposing of equipment and, if possible, take Chlorofluorocarbon-based foam insulation to a recycler who can capture Chlorofluorocarbons.
Use durable products and materials.	Because manufacturing is very energy-intensive, a product that lasts longer or requires less maintenance usually saves energy. Durable products also contribute less to solid waste problems.
Choose building materials with low embodied energy.	One estimate of the relative energy intensity of various materials (by weight) is as follows: Lumber = 1, Brick = 2, Cement = 2, Glass = 3, Fiberglass = 7, Steel = 8, Plastic = 30, Aluminum = 80
Buy locally produced building materials.	Transportation is costly in both energy use and pollution generation. Look for locally produced materials to replace products imported to your area.
Use building products made from recycled materials.	Building products made from recycled materials reduce solid waste problems, cut energy consumption in manufacturing, and save on natural resource use.
Use salvaged building materials when possible.	Reduce landfill pressure and save natural resources by using salvaged materials: lumber, millwork, certain plumbing fixtures, and hardware, for example.
Avoid materials that will offgas pollutants.	Solvent-based finished, adhesives, carpeting, particle board, and many other building products release formaldehyde and volatile organic compounds (VOCs) into the air. These chemicals can affect workers' and occupants' health as well as contribute to smog and ground-level ozone pollution outside.
Minimize use of pressure-treated lumber.	Use detailing that will prevent soil contact and rot. Where possible, use alternatives such as recycled plastic lumber. Take measure to protect workers when cutting and handling pressure-treated wood, and never burn scraps.
EQUIPMENT	
Install high-efficiency heating and cooling equipment.	Well-designed high-efficiency furnaces, boilers, and air conditioners (and distribution systems) not only save money, but also produce less pollution during operation. Install equipment with minimal risk of combustion gas spillage, such as sealed-combustion appliances.
Install high-efficiency lights and appliances.	Fluorescent lighting has improved dramatically in recent years and is now suitable for homes. High-efficiency appliances offer both economic and environmental advantages over their conventional counterparts.
Install water-efficient equipment.	Water-conserving toilets, showerheads, and faucet aerators not only reduce water use, they also reduce demand on sewage treatment plants. Reducing hot water use also saves energy.
Install mechanical ventilation equipment.	Mechanical ventilation is usually required to ensure safe, healthy indoor air. Heat recovery ventilators are preferred in cold climates because of energy savings, but simpler, less expensive exhaust-only ventilation systems are also adequate.

Adapted from RMI, 1995.

- Demonstration projects

Construction and monitoring of experimental or pilot projects that demonstrate innovative concepts is often a useful method of showcasing efficiency.

- Municipal design review criteria

Adding stronger energy efficiency items to Chula Vista's existing design review criteria would help institutionalize efficiency and lead to more energy-conscious projects generally.

- Expedited permit reviews and bonuses

The City could offer expedited permit reviews or other zoning bonuses to builders who voluntarily exceed minimum code energy standards.

The Task Force and City staff have indicated interest in combining these voluntary measures into a Chula Vista "Greenstar" program that stresses information dissemination and recognition of outstanding efforts.

In addition to voluntary implementation, the strategy should include ongoing review of building code standards to ensure that they reflect improving technologies and efficiencies. This part of the strategy requires the assistance of local building officials, designers, and builders who are best equipped to study code changes in detail and recommend appropriate amendments. Code amendments can be proposed not only at the local level, but also importantly for CO₂ reduction, at the state and national code levels as well.

Municipal

This category of CO₂ reduction measures concerns City government keeping its own emissions to a minimum. This includes everything from operating municipal vehicles to space conditioning municipal offices. The municipal category is organized as follows:

- Municipal management
 - Comprehensive energy accounting
- Municipal transportation
 - Employee commuting
 - Clean fuel conversion/purchase
 - High efficiency conventional fuel vehicle purchase
 - Maintenance and driving improvements.
- Municipal buildings
 - Space conditioning
 - Lighting
 - Office equipment
- Municipal infrastructure
 - Street lights
 - Traffic signals
 - Large pumps and motors

Municipal measures have been reviewed under the broader general categories of transportation and building efficiency, except for energy accounting. An energy accounting system allows a city to track energy use room-by-room, building-by-building. This provides insight for decision makers on where conservation will be more or less effective. This is perhaps the most noteworthy municipal measure because the lack of an energy accounting system severely handicaps any municipal energy improvement effort. Based on interviews with City staff and review of municipal records, it does not appear that Chula Vista is readily able to track energy use comprehensively; nor to identify usage anomalies and take focused corrective action. An energy accounting system will perform these duties, which are essential for achieving reliable and consistent energy and CO₂ reductions. One of the most popular systems of this type is ENACT, which is available from the Washington State Energy Office. Use of a system like this can produce the following benefits:

- Identifying where energy is being wasted or used inefficiently.
- Showing where energy costs have been reduced in order to confirm conservation effectiveness.

- Providing better information for budgeting and capital improvement programming.
- Providing a rational basis for evaluating competing energy efficiency options.
- Identifying billing and rate schedule errors.
- Promoting energy cost savings so funds can be redirected to other municipal needs.

Electricity and Natural Gas Supply Systems

In contrast to all of the foregoing categories of CO₂ action that can be directly controlled by City government, this category is concerned with municipal advocacy of CO₂ reduction by organizations supplying electricity and natural gas to the community.

The issues under these organizations' control that affect CO₂ emissions include:

- Efficiency improvements in existing electric and natural gas supply systems (SDG&E, other investor-owned utilities, independent producers, state, federal).
- Use of low carbon intensity fuels in new electric generation (SDG&E, other investor-owned utilities, independent producers, state, federal).

Opportunities for Chula Vista to advocate CO₂ reductions occur regularly in the electric and natural gas supply policy areas. A prominent example at present is the California Public Utilities Commission's intent to deregulate electricity services. In this case, municipalities could have an opportunity to promote consideration of environmental issues such as CO₂ reduction when electric utilities are competing in a deregulated market. The League of California Cities supports electricity deregulation if it results in permanently lower rates and complies with the following criteria:

- Equitable benefits: any restructuring program should result in all ratepayers directly sharing benefits equitably.

- Municipal utilities: any restructuring program should consider the viability of municipal utilities.
- Franchise authority: cities should continue to have the authority to issue franchises, and any restructuring should be at least revenue neutral relative to current franchise revenues.
- Municipalization: cities should be authorized to serve as brokers/facilitators in negotiating, buying, transmitting, and distributing electricity for their businesses and residents.

Because of the intangibility of policy advocacy, CO₂ savings from this category cannot be easily estimated or quantified. If the City takes a relatively proactive posture in these issue areas, and consistently participates in applicable legislative and regulatory processes, it is reasonable to believe that such advocacy will produce several thousands of tons of CO₂ savings during the planning period.

Regional/State/Federal Policies

This is also an advocacy category where the City can participate in other government forums to express Chula Vista preferences or proposals. Opportunities for promoting local objectives occur in the following regional, state, and/or federal policy areas:

- Vehicle fuel efficiency standards (federal)
- Vehicle pollutant emissions standards (federal, state, regional)
- Building construction standards (federal, state)
- Appliance standards (federal, state)
- Forestry policies (federal, state)

This is another intangible policy category where CO₂ savings cannot be easily quantified. However, as with electric and natural gas advocacy, it is reasonable to believe that if the City actively and consistently participates, that such advocacy could produce another 1-2% of desired CO₂ savings. More importantly, such advocacy is critical to developing global warming policies along at higher levels of government.

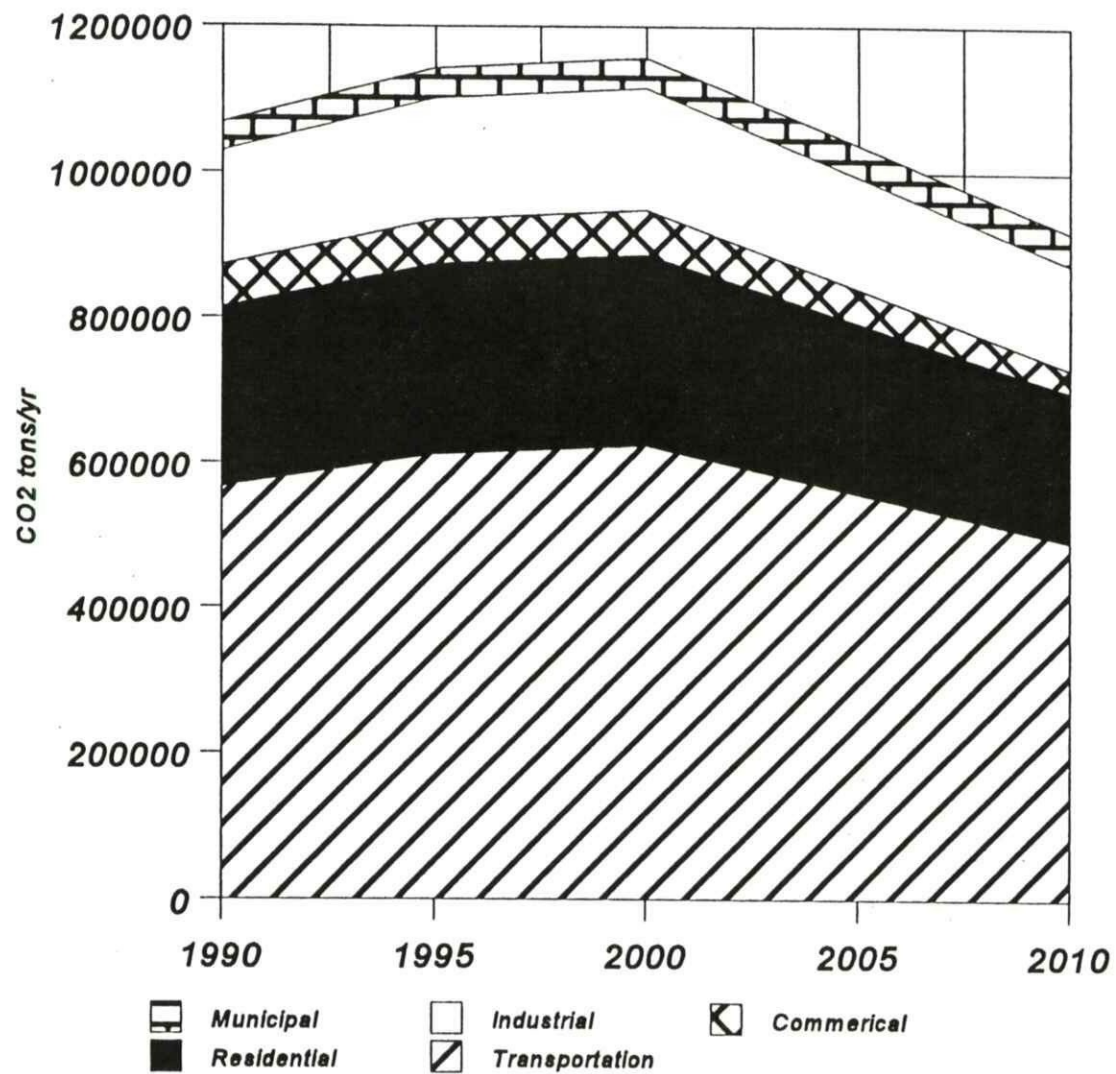
The Strategy

As estimated in Chapter 3, Chula Vista will need to reduce its projected 2010 CO₂ emissions by approximately 400,000 tons/yr in order to achieve the international goal of 80% of 1990 emissions in 2010. To achieve this goal, the following eight-part strategy is proposed:

1. To spur action, increase the public's awareness of the climate change issue. Focus in particular on the next generation of Chula Vistans who can make CO₂ reduction an everyday practice by 2010.
2. Reduce the long-term need for travel in the community through efficient land-use/transportation coordination and telecommunications technology. Focus in particular on shaping areas east of Interstate 805 to be as CO₂ friendly as possible.
3. Of the travel that does occur, provide for multi-modal choices.
4. Of the automobile driving that remains, work to make it as clean as possible.
5. Capture cost-effective building efficiency improvements in both new construction and remodeling through a mix of implementation approaches.
6. Lead the effort with municipal efficiency gains that can be showcased to encourage personal and organization action throughout the community.
7. Interlock the City's efforts with other regional programs in order to strengthen region-wide progress on climate protection.
8. Focus initially on a few short-range actions to build visibility and results, and then periodically update and fine tune the strategy over time.

With the involvement and hard work of Chula Vista's stakeholders, this strategy can lead to the downward curve of CO₂ emissions shown in Figure 4.4.

Figure 4.4
CO₂ REDUCTION STRATEGY: 1990 - 2010
 (Annual emissions by end use sector)



5. GOALS & POLICIES



CO₂ REDUCTION GOAL & POLICIES

Having formed a reduction strategy and estimated possible CO₂ savings, the next planning steps are: 1) expression of a specific reduction goal; and 2) expression of policies for guiding day-to-day municipal actions toward the stated goal.

Goal

Reduce Chula Vista's CO₂ emissions to 80% of 1990 levels by the year 2010. This is equivalent to a savings of approximately 400,000 tons/yr in 2010 compared to projected emission levels without any municipal action.

Policies

The proposed policies for achieving the City's reduction goal are:

1. Include CO₂ emissions and global warming impacts as determinant in policy-making and program administration related to the long-term sustainability of the community.
2. Meet the energy needs of the community with a portfolio of low carbon intensity resources, preferably local-based efficiency improvements and renewable resources.
3. Treat transportation as the highest priority CO₂ action area because of its high CO₂ emissions, significant potential for savings, and major environmental and economic improvement opportunities.
4. Use land-use planning and development standards to shape a built environment that minimizes travel needs and maximizes access to non-auto travel modes.
5. Implement cost-effective energy efficiency in new and existing residential and nonresidential buildings.

6. Exercise municipal leadership by implementing cost-effective energy efficiency in public facilities and services, including use of life-cycle energy economics as a selection criterion when purchasing energy-using devices and constructing municipal facilities.
7. Provide ongoing support for cooperative regional planning related to energy efficiency and global warming.
8. Monitor CO₂ reduction progress, and revise and update the CO₂ plan at least every five years.

6. ACTION PLAN



CO₂ ACTION PLAN

Having established a reduction goal and policies, the final planning step is designing an action plan to implement the policies and achieve the goal. This chapter describes an action plan composed of the following elements:

- Ongoing CO₂ reduction projects.
- A set of 20 actions to be implemented following plan adoption.

The key to successfully undertaking this effort is an aware and engaged group of stakeholders who are actively committed to nuts-and-bolts progress. Table 6.1 summarizes the types of attributes needed in Chula Vista in order to effectively carry out the plan.

Ongoing Projects

Chula Vista is already conducting several projects that are producing CO₂ savings, or that are in the planning stages and nearly ready for implementation. One objective of this plan is to integrate these ongoing projects into the overall reduction strategy, and to build on the momentum that these projects have already created.

The City's current CO₂ projects include:

- *Smogbuster alternative fuel vehicle rebates.* The City has an ongoing alternative fuel retrofit rebate program targeted at private industry. It allows for a maximum of 20 retrofits to electric and CNG, and a minimum of 10 retrofits. The City is providing up to \$4,000 for electric and \$1,000 for CNG per retrofit.
- *Hydrogen transit vehicles.* The City is currently raising funds to conduct a hydrogen fuel transit demonstration. These buses produce no emissions and their only byproduct is water. Chula Vista has plans to replace three diesel buses with a state-of-the-art technology run entirely on hydrogen as a fuel, which results in zero emissions. The City will be one of 3 pilot project sites in North America, demonstrating the results of a major R&D effort to convert NASA aerospace technology to a practical, commercial application.

Table 6.1
KEYS TO CO₂ PROGRAM SUCCESS

- **Widespread awareness of transportation and energy alternatives.** *In many communities, residents seldom think of global climate, transportation, and energy issues together, much less see improved energy use as a means to a better environment and stronger economy. In communities that are making improvements, awareness of climate change and energy efficiency are becoming commonplace as people incorporate cost-effective efficiency methods into everyday practice.*
- **Incentives to change.** *Community members see that it is in their best interest to take advantage of energy efficiency for economic, environmental, or other reasons. Rather than an issue that only a few citizen activists care about, improving energy use and reducing CO₂ emissions becomes a community priority directly tied to important local and global goals.*
- **Community and political support.** *Good ideas without community and political backing often go nowhere. Strong and enthusiastic support from elected officials, civic leaders, and the community at large plays a critical role in turning good ideas into lasting local change.*
- **Strong local leadership.** *Someone in the community, or some organization, has a vision of how CO₂ emissions can be reduced and the economy improved. They take an active, persistent role in turning community potential into reality.*
- **Ability to mobilize resources.** *Education and the resulting awareness of energy efficiency alternatives is not enough. Successful CO₂-efficient communities have made the most of available resources to help residents and businesses overcome barriers such as a lack of up-front financing or technical expertise.*
- **An effective organization to carry the effort on, year after year.** *While individual actions are critical to success, institutions and organizations create a reliable base to mobilize the necessary resources to make improved energy use an ongoing priority for years to come.*

Adapted from Hubbard, 1995.

The project will run for 500,000 miles and result in zero emissions. The City has calculated a CO₂ savings of 2,722 CO₂ tons per year. This project has received financial support from the California Energy Commission, the California State legislature, U.S. Department of Energy and the City of Chula Vista.

\$5.3 million has been raised out of a total \$6.4 million needed for the project. The City plans to purchase three hydrogen fuel cell buses and replace two diesel buses and add one new transit line to the City's system.

- *Aluminum air fuel cell research and development (R & D).* Currently the City is part of a team, along with SCAQMD and SAIC, to refine a zero emission aluminum air fuel cell for portable generators and transportation applications. SAIC is currently developing a contract with the military to supply portable power generators with this technology, but the vehicle application is still in the research phase. The next step is to build an aluminum air truck and test it in Chula Vista's fleet. This project will not result in short term savings, but if the R&D effort is successful, the company has committed to developing a manufacturing facility in Chula Vista.
- *Vanpool.* The City is in the process of purchasing three CNG ULEV seven-passenger minivans for City employee vanpooling. This program will eventually expand to include employees from nearby private companies. Routes have been designated as followings: Vista - Chula Vista route (along I-15 with pick-ups in Vista, Escondido, and Poway areas to Chula Vista and back); Coast Routes (Carlsbad, La Jolla, down to Chula Vista); and East County Routes (Murrieta, Temecula, Alpine, El Cajon, etc.).
- *Telecommuting and telecenters.* City employees participate in telecommuting, and the City has established two telecenters. Together the two telecenters have a maximum occupancy potential of 90 telecommuter spaces per week, plus two classrooms and one conference room. As of July 1995, the downtown telecenter has a 27% occupancy rate, which translates into 12 telecommuter days. The East H Street telecenter has a 36% occupancy rate, which translates

into 18 telecommuter days. Occupancy levels are projected to rise to 50% by December and 75% by July 1996.

- *Lighting upgrades.* Energy efficient lighting upgrades have been installed in municipal buildings.

The current or expected CO₂ savings from these projects are summarized in Table 6.2, and each of them is detailed further in Appendix E.

20 Action Measures

The core of the action plan is the set of 20 measures recommended by the Task Force for implementation following plan adoption. These are listed in Table 6.3 and summarized according to estimated impacts in Table 6.4. Each of the measures is also detailed in Appendix F according to implementation costs, expected savings, implementation responsibilities and schedule, and funding options. Figure 6.1 illustrates the percent of CO₂ savings estimated for the 20 measures when fully implemented in 2010, and Figure 6.2 groups the savings into three major categories of measures.

As shown in Table 6.4, the action measures are estimated to produce about 100,000 tons/yr of CO₂ savings by 2010, which is approximately one quarter of the savings needed to achieve the international reduction goal. These measures are estimated to cost roughly \$25 million in capital outlays, and another \$5 million in annual operating and maintenance expenses over the next 14 years. This total implementation cost of approximately \$95 million is contrasted against a total savings estimate of \$130 million by 2010. These savings include \$16 million in reduced energy expenses; about \$5 million in avoided CO₂ damage (using the CEC's damage cost coefficient of \$50/ton); and about \$109 million in avoided auto/truck driving expenses (using the CEC's cost of driving coefficient of 71¢/mile). It should be noted that both costs and savings will be shared by many stakeholders in the community, including municipal government, businesses, homeowners, and other regional organizations.

For reference purposes, Appendix F contains the remaining 70 preferred CO₂ reduction measures that are available for future implementation. Appendix H contains definitions and CO₂ savings estimates for the 168 measures originally presented by the consultant for Task Force review and evaluation.

Table 6.2
CO₂ PROJECTS ALREADY UNDERWAY

<u>Project</u>	<u>CO₂ Savings (tons/yr)</u>
<i>Alternate fuel vehicle rebates</i>	27
<i>Hydrogen bus demonstration</i>	2,722
<i>Vanpooling</i>	1,736
<i>Lighting upgrades</i>	514
<i>Telecenters</i>	<u>75</u>
	5,074

Education Program:

The City developed a Global Warming curriculum for the Chula Vista Elementary School District. This effort is not quantifiable but nevertheless is anticipated to result in emission reductions. The District implemented the curriculum, to be used on an annual basis.

Table 6.3
ACTION MEASURES

1. *Municipal clean fuel vehicle purchases.*
2. *Green Power (Replaced "Private Fleet Clean Fuel Vehicle Purchases" 6/98)*
3. *Municipal Clean Fuel Demonstration Project*
4. *Telecommuting and Telecenters*
5. *Municipal Building Upgrades and Trip Reduction*
6. *Enhanced Pedestrian Connections To Transit*
7. *Increased Housing Density Near Transit*
8. *Site Design with Transit Orientation*
9. *Increased Land Use Mix*
10. *Green Power Public Education Program (Replaced "Reduced Commercial Parking Requirements" 6/98)*
11. *Site Design with Pedestrian/Bicycle Orientation*
12. *Bicycle Integration with Transit and Employment*
13. *Bicycle Lanes, Paths and Routes*
14. *Energy Efficient Landscaping*
15. *Solar Pool Heating*
16. *Traffic Signal and System Upgrades*
17. *Student Transit Subsidy*
18. *Energy Efficient Building Recognition Program*
19. *Municipal Life-Cycle Purchasing Standards*
20. *Increased Employment Density Near Transit*

Table 6.4
ACTION MEASURE IMPACTS

Measure	CO ₂ Saved (tons/yr)	Implementation Cost in the Year 2010 (\$)	O&M Cost (\$/yr)	VMT Saved (miles/yr)	Energy Saved (MMBtu/yr)	Energy Costs Saved (\$/yr)	Saved CO ₂ Damage (\$)	Avoided Driving (\$)
1. Municipal clean fuel vehicles	251	661,214	---	---	1,838	36,010	12,561	---
2. Private clean fuel vehicles	3,471	6,185,618	---	---	23,806	643,402	173,567	---
3. Municipal clean fuel demonstrations	2,722	7,000,000	3,000,000	---	34,022	---	21,012	---
4. Telecommuting/telecenters	367	100,000	240,000	923,140	4,823	67,650	18,327	655,429
5. Municipal bldgs./employee trips	799	506,048	4,610	264,915	6,046	157,487	39,942	188,090
6. Pedestrian/transit connections	6,328	---	---	15,936,505	83,258	985,214	316,380	11,314,919
7. Housing density near transit	8,744	---	---	22,022,805	115,055	1,361,477	437,209	15,636,192
8. Transit oriented site design	4,372	---	---	11,011,403	57,527	680,738	218,604	7,818,096
9. Increased land-use mix	8,744	---	---	22,022,805	115,055	1,361,477	437,209	15,636,192
10. Reduced commercial parking	6,328	---	---	15,936,505	83,258	985,214	316,380	11,314,919
11. Pedestrian/bicycle site orientation	4,372	---	---	11,011,403	57,527	680,738	218,604	7,818,096
12. Bicycle/transit/employment integration	2,417	125,000	5,000	6,086,300	31,797	376,262	120,829	4,321,273
13. Bicycle lanes/paths/routes	1,447	5,417,000	---	3,615,303	19,076	225,728	72,361	2,592,425
14. Energy efficient landscaping	1,279	866,668	---	---	8,674	218,500	63,931	---
15. Solar pool heating	2,462	1,260,000	---	---	42,394	379,847	123,111	---
16. Traffic signals	1,640	2,053,667	---	---	21,357	256,391	81,996	---
17. Student transit subsidy	3,878	---	792,000	9,786,155	51,126	604,992	193,940	6,948,170
18. Greenstar program	15,591	---	30,000	---	105,775	2,664,477	779,596	---
19. Municipal purchasing standards	10,151	100,000	5,000	---	68,869	1,729,994	507,587	---
20. Employment density near transit	13,355	---	---	33,634,773	175,720	2,079,343	667,736	23,880,688
Total	98,718	24,275,215	4,076,610	152,252,012	1,107,003	15,494,941	4,820,882	108,124,489

All costs are in 1995 dollars; see Section 7 for additional measure information and data sources.

Figure 6.1
ACTION MEASURE CO2 SAVINGS BY PERCENT OF TOTAL SAVINGS

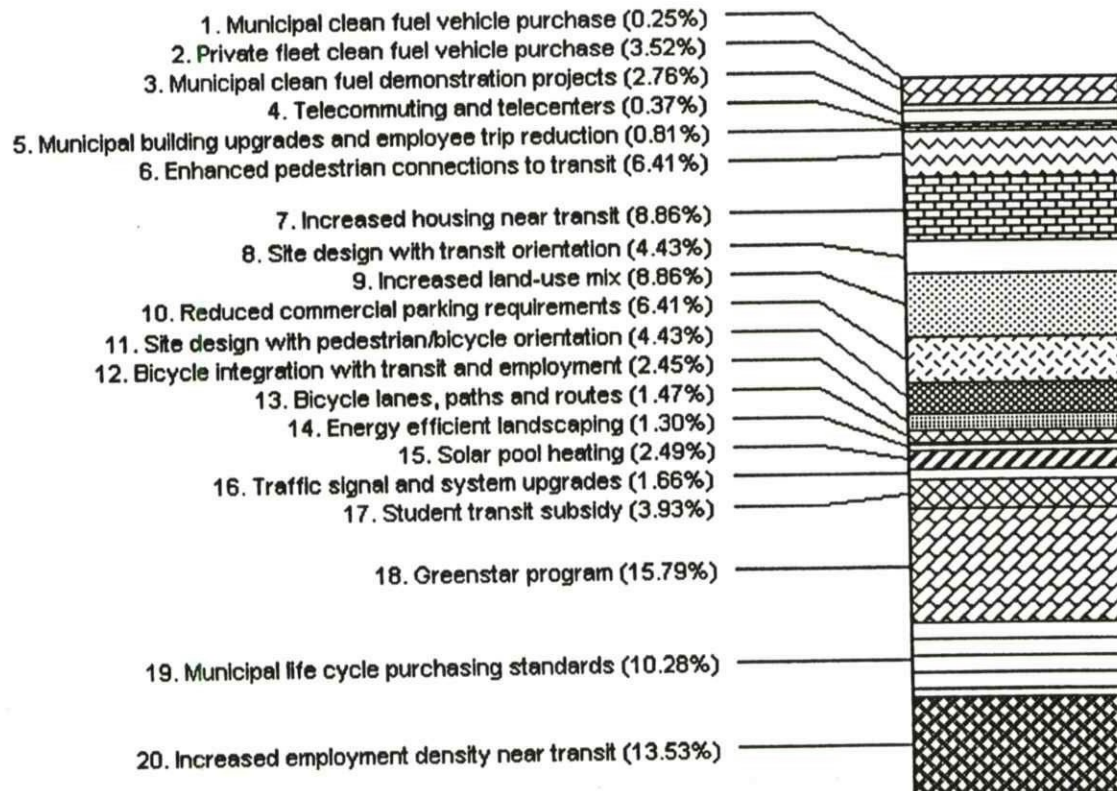
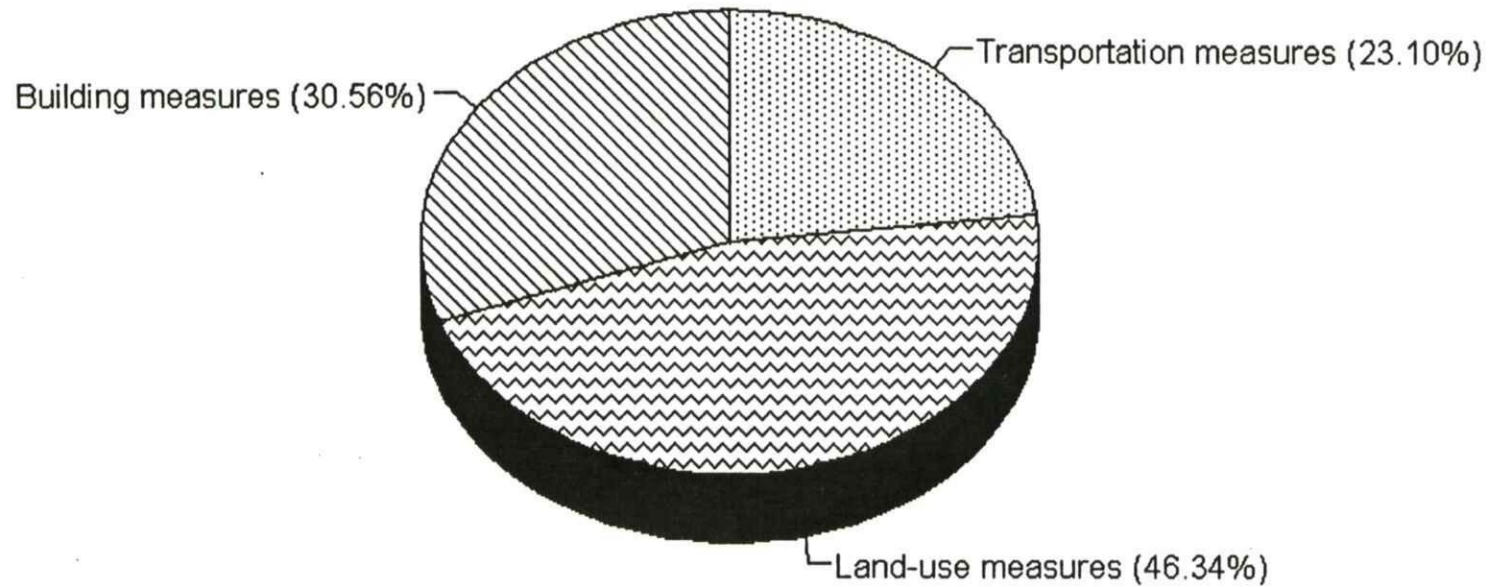


Figure 6.2
**MAJOR CATEGORIES OF ACTION MEASURE CO₂ SAVINGS
BY PERCENT OF TOTAL SAVINGS**



7. CO₂ REDUCTION PLAN IMPLEMENTATION AND ACTION MEASURES



ACTION MEASURES

This chapter describes the CO₂ plan's proposed action measures as follows:

- Measure description and estimated CO₂ savings in 2010.
- Target sector and expected sector penetration.
- Implementation costs and estimated savings.
- General economic or fiscal impacts.
- Implementation responsibilities, schedule, and funding options.

The committee did a cursory preliminary review of some funding options for implementation. The list generated reflects consultant and staff input as well, but does not represent the total universe of funding options. Funding options for the short-range action measures are listed below, including the letter designation used to code the options for applicability in the following measure summaries:

- A. *Partnerships with benefitted public and private organizations.* This includes both cash and in-kind contributions, and is an important way of leveraging funds in projects where there are multiple beneficiaries.
- B. *Air quality/traffic mitigation funds and development impacts fees.* These sources could be used to address new CO₂ emissions created by community growth.
- C. *Municipal department energy bills.* Each municipal department could contribute an amount equivalent to 1% of its annual energy bill to a common pool of efficiency funding that departments could borrow from and repay with a portion of their energy savings.
- D. *Vehicle registration funds.* These are highly competitive but nonetheless useful funds available on a biennial basis. These funds are available principally to reduce motor vehicle-related emissions and for related planning, monitoring, enforcement and technical studies necessary for California Clean Air Act implementation.
- E. *SANDAG transit/bicycle facility funds.* These are increasingly scarce federal and state capital construction monies, but again still worth pursuing where feasible.
- F. *CEC Petroleum Violation Escrow Accounts (PVEA).* In addition to usual grant competition, PVEA funds are diminishing every year, but their flexibility in terms of eligible uses continues to make it an attractive source.

- G. *EPA "transportation partners" program and others.* Unlike some EPA programs, transportation and energy have not been substantially reduced in FY 96.
- H. *Department of Energy energy efficiency and renewables.* Several discretionary funding programs are applicable to Chula Vista measures.
- I. *Department of Transportation Intermodal Surface Transportation Enhancement Act (ISTEA) and others.* Several discretionary programs are applicable to Chula Vista.
- J. *Housing and Urban Development community development block grants (CDBG).* CO₂ projects with a strong housing or neighborhood improvement component could qualify for CDBG funds.
- K. *Energy service companies.* ESCOs will provide their own capital funding for turn-key projects, and will share the savings stream with the City.
- L. *Land-use efficiency revenue from utility providers.* Given its land-use planning power, the City could "sell" the energy savings inherent in its development decisions to SDG&E based on transmission and distribution savings gained by the utility; similar concepts are under consideration with PG&E and BC Hydro.
- M. *Municipal general fund.* This is the least desirable option, but should be considered for small CO₂ program support needs.

CO₂ reduction savings estimates that appear in the following measure summaries include: 1) direct cost savings from reduced energy consumption, based on local energy rates; 2) the direct and indirect value of avoided driving (exclusive of fuel) based on a rate of \$0.71/mile (Moore, 1994); and 3) avoided CO₂ damage to the environment, public health, and economy based on a rate of \$50/ton (USDOE, 1994). Capital and operating cost estimates for the measures have been taken from the references cited with each measure or provided by City staff in applicable departments. The primary sources of information for expected measure performance and savings estimates include: SANDAG's regional plan for transportation control measures; the CEC's Transportation Energy Analysis Report for clean fuel measures; and the CEC's Database for Energy Efficient Resources (DEER) for building and infrastructure measures. All costs are expressed in 1995 dollars.

Measure 1

MUNICIPAL CLEAN FUEL VEHICLES

Description

Purchase of clean fuel vehicles during normal turn-over of municipal fleet between 1996-2010. Includes electric, natural gas, and other alternative fueled vehicles.

CO₂ Reduction

251 tons/yr in 2010.

Target Sector

Municipal government. There are currently about 330 vehicles in the municipal fleet; this is projected to grow to 400 by 2010.

Sector Penetration

30 - 50% annually of all gasoline vehicles purchased, increasing to 70 percent by 2000.

Implementation Costs

Approximately \$660,000 in total 1996-2010 incremental capital costs above conventional fuel vehicles; although cost reductions are expected as clean fuel vehicles become more widely used between 2000-2010. O&M costs are assumed to be equivalent to conventional fuel vehicles. Additional implementation costs will include a \$400,000 CNG fueling facility at a new corporation yard.

Savings (\$/yr in 2010)

Energy	\$46,000
Avoided CO ₂ damage	<u>16,000</u>
	\$62,000

Fiscal Impacts

Lower municipal energy costs. Reduced damage costs associated with projected air quality/global warming.

Implementation Responsibilities

Primary:	City fleet managers
Support:	CO ₂ program

Funding Options

C,F,G,H,I,M

Implementation Schedule

Already ongoing.

Measure 1 *Continued*

Implementation Steps

1. City fleet management staff are already moving toward clean fuel vehicles, and this measure simply proposes a formalization of the City's commitment to ultimately operating a municipal fleet known for its emission reduction benefits.
2. Because the early years of this measure are capital intensive, staff emphasis should be placed on raising funds to buy-down the incremental cost of new clean fuel vehicles. In addition, under the life-cycle policy of this plan, the City Council may want to simply acknowledge that the cost of operating a clean municipal fleet is worth 15-20% more than business-as-usual until clean fuel vehicles begin to decrease as expected.
3. Clean fuel fleet vehicles should be monitored to evaluate their performance and energy and CO₂ savings.
4. Future plans for a new corporation yard should include alternative fueling facilities.
5. The City has agreed to participate in the Clean Cities Coalition.

7. CO₂ Reduction Plan Implementation and Action Measures

Measure 2

GREEN POWER

Replaced Private Fleet Clean Fuel Vehicles June 1998

In June 1998 the City of Chula Vista joined the SANDAG Power Pool and switched approximately 12 of the highest load consumption meters to "green power" or electricity generated from renewable resources. This resulted in a reduction in CO₂ emissions in addition to a savings in energy costs. In June 1999 the agreement was renewed and Council authorized the Energy Service Provider (ESP) to switch additional meters to green power. Due to the large number of meters under the Power Pool, the ESP was not able to execute the switch out. As of July 2000, the Power Pool has ceased to operate as an aggregator of renewable energy and all of the switched meters defaulted back to SDG&E. Staff is currently in the process of working with several ESP's to identify green electricity purchase options available to the City of Chula Vista. As a result of the land use permit to site a "peeker" power plan, the City has also negotiated with PG&E to receive up to \$30,000 in funding and in-kind services to develop photovoltaic (solar) electricity at one City facility.

Measure 2

PRIVATE FLEET CLEAN FUEL VEHICLES

Description

Purchase of clean fuel vehicles during normal turn-over of private fleets.

CO₂ Reduction

3,500 tons/yr in 2010.

Target Sector

Transportation. Currently there are about 1,800 vehicles of all fuel types in private fleets in Chula Vista. This is projected to grow to 4,000 vehicles in 2010. About 45% of the private fleet is gasoline-powered.

Sector Penetration

100% of gasoline fleet vehicles or 1,600 vehicles in 2010.

Implementation Costs

Approximately \$6.1 million in total 1996-2010 incremental capital costs. O&M is assumed to be equivalent to conventional fuel vehicles.

Savings (\$/yr in 2010)

Energy	\$643,000
Avoided CO ₂ damage	<u>173,567</u>
	\$817,000

Economic Impacts

Reduced damage costs associated with projected air quality/global warming; and lower energy costs and increased savings for fleet operators.

Implementation Responsibilities

Primary:	Private fleet managers
Support:	City CO ₂ program

Funding Options

A,D,F,G

Implementation Schedule

Already ongoing.

Measure 2 Continued

Implementation Steps

1. Fleet operators should be organized into a network of allied stakeholders who are periodically briefed and invited to advance the clean fuel agenda in cooperation with the City.
2. City staff should maintain an inventory of private fleet characteristics, and the performance of clean fuel vehicles in those fleets for use in related CO₂ program marketing and evaluation.
3. City staff should cooperate with private fleet operators in developing alternative fueling infrastructure at locations throughout Chula Vista, including removal of any unnecessary municipal regulatory barriers.
4. The stakeholder group should include local colleges capable of providing job training aimed at maintenance of clean fuel vehicles and fueling infrastructure.
5. The stakeholders should work to recruit designers and parts manufacturers supplying components to the clean fuel industry to further reinforce local applications of the technology.
6. Participation in the Clean Cities program and the San Diego Regional Alternative Fuel Vehicle Coalition.

Measure 3

CLEAN FUEL DEMONSTRATION PROJECT

Description

High visibility pilot demonstration of new clean fuel technologies. The first project is hydrogen buses for the City transit system. A total of three hydrogen buses are proposed which will be operated in the city system (Chula Vista Transit). This program results in an annual net energy savings of 3,634 million BTU.

CO₂ Reduction

2,700 tons/yr in 2010.

Target Sector

Transportation

Sector Penetration

The addition of two clean fuel buses to the City transit system would be about a 6% penetration of the system's current 31-bus fleet.

Implementation Costs

Approximately \$6.5 million in capital costs including O&M.

Savings (\$/yr in 2010)

Avoided CO₂ damage \$82,000

Economic Impacts

Reduced air quality/global warming damage costs; support for technology commercialization.

Implementation Responsibilities

Primary: City transit system
Support: City CO₂ program

Funding Options

A,F,G,H,I,M

Implementation Schedule

Fund raising should be completed in 1996, with the first buses operating by 1998.

Measure 3 *Continued*

Implementation Steps

1. Because the Ballard hydrogen bus is already in operating prototype form, the implementation effort is relatively straightforward: funding the manufacture of additional units; selecting the demonstration routes; and operating the buses under monitored conditions. Additional information on this measure is available under separate cover from the City.

Measure 4

TELECOMMUTING AND TELECENTERS

Description

Working at home via computer link, and at nearby centers to avoid or reduce commute trips. Ten new neighborhood telecenters are proposed in addition to the existing two centers.

CO₂ Reduction

367 tons/yr in 2010.

Target Sector

Transportation

Sector Penetration

2% of work force by 2010 (combined telecommuting and telecenters).

Implementation Costs

Approximately \$500,000 in total 1996-2010 capital costs; O&M is estimated at \$1.2 million/yr in 2010.

Savings (\$/yr in 2010)

Energy	\$135,000
Avoided driving	1,306,000
Avoided CO ₂ damage	37,000
	<u>\$1,478,000</u>

Economic Impacts

Reduced cost for work commute driving; improved worker productivity; increased business patronage by workers remaining in town during the work day.

Implementation Responsibilities

CO₂ program

Funding Options

A,B,D,E,F,G,H,I,M

Implementation Schedule

Already ongoing; establishment of employer telecommuting programs during 1996-2006.

Measure 4 *Continued*

Implementation Steps

1. This is another case of a measure that is already well underway, and in fact, already demonstrating some successes. This has lead to the City's approach being used as a model elsewhere in California for other communities starting such efforts.
2. The proposed expansion of this measure during 1996-2010 envisions ten new telecenters strategically sited to put one in every neighborhood. Particular emphasis should be given to making the telecenters part of multi-purpose activity centers at the neighborhood level. Implementation should be coordinated with related land-use/transportation measures that will promote mixed-uses in neighborhoods.
3. The current monitoring effort should continue to evaluate savings of driving, energy, and CO₂.

Measure 5

MUNICIPAL BUILDING UPGRADES & EMPLOYEE TRIP REDUCTION

Description

Energy efficiency retrofits of municipal buildings, and employee trip reduction through telecommuting and vanpooling.

CO₂ Reduction

799 tons/yr in 2010.

Target Sector

Municipal government.

Sector Penetration

By 2010, 100% of municipal buildings, 30 employees telecommuting, and 100 employees vanpooling.

Implementation Costs

Approximately \$505,000 in capital costs; approximately \$4600/yr O&M for vanpooling.

Savings (\$/yr in 2010)

Energy	\$157,487
Avoided driving	188,090
Avoided CO ₂ damage	<u>39,942</u>
	\$385,519

Fiscal and Economic Impacts

Lower municipal energy costs. Reduced damage costs associated with projected air quality/global warming. Also increased employee savings from reduced driving.

Implementation Responsibilities

Municipal building managers and employee trip reduction coordinator.

Funding Options

A, C, F, H, K, M.

Implementation Schedule

Already ongoing.

Measure 5 *Continued*

Implementation Steps

1. Continue to implement ongoing building retrofit and employee trip reduction programs.
2. Strengthen the building retrofit program with a comprehensive energy accounting system as recommended in Chapter 4.
3. Strengthen the employee trip reduction program through partnerships with other organizations implementing similar efforts.

Measure 6

ENHANCED PEDESTRIAN CONNECTIONS TO TRANSIT

Description

Installation of direct, convenient walkways and crossings between bus stops and surrounding land-uses.

CO₂ Reduction

6,300 tons/yr in 2010.

Target Sector

Transportation

Sector Penetration

N/A

Implementation Costs

Marginal increase in standard site development and maintenance costs.

Savings (\$/yr in 2010)

Energy	\$985,000
Avoided driving	11,315,000
Avoided CO ₂ damage	<u>315,000</u>
	\$12,615,000

Economic Impacts

Increased patronage of businesses in the vicinity of bus stops; increased personal savings from reduced driving.

Implementation Responsibilities

Joint working group including municipal transit system, MTDB, Planning department, and Engineering department.

Funding Options

A,B,E,F,J,M

Implementation Schedule

1996-2010; dependent on rate of new development and available funding for retrofits.

Measure 6 *Continued*

Implementation Steps

1. Convene a working group of staff from the municipal transit, and planning, engineering MTDB to identify priority projects for redesign toward enhanced pedestrian connectivity to transit.
2. Review past experience and existing conditions to identify general levels of transit accessibility by pedestrians.
3. Identify revised standards and procedures for enhancing connections in new development areas.
4. Identify methods of retrofitting problem sites in older neighborhoods.
5. Prioritize new and retrofit opportunities, and initiate installation of improvements.

Measure 7

INCREASED HOUSING DENSITY NEAR TRANSIT

Description

General increase in land-use and zoning designations to reach an average of 14-18 dwelling units per net acre or more within 1/4 mile of major transit routes and stops throughout the City.

CO₂ Reduction

8,700 tons/yr in 2010.

Target Sector

Transportation

Sector Penetration

N/A

Implementation Costs

N/A

Savings (\$/yr in 2010)

Energy	\$1,360,000
Avoided driving	15,636,000
Avoided CO ₂ damage	440,000
	<u>\$17,436,000</u>

Economic Impacts

Increased personal and business savings from reduced driving.

Implementation Responsibilities

Planning, Public Works, and Community Development Departments.

Funding Options

L

Implementation Schedule

1996-2010; dependent on rate of new development and opportunities for redevelopment.

Measure 7 Continued

Implementation Steps

1. The Planning Department is already implementing this measure in several areas of the City, including Otay Ranch by utilizing the SANDAG Land-Use Distribution Element as a framework. The policy should continue to be incorporated into appropriate general plan updates, zone changes, and other applicable land-use standards.
2. The City should work with the APCD in developing its proposed indirect source program whose objectives are consistent with CO₂ reduction.
3. The City should develop a transit-oriented development overlay zone for application to major transit centers.

Measure 8

SITE DESIGN WITH TRANSIT ORIENTATION

Description

Placement of buildings and circulation routes to emphasize transit rather than auto access; also includes bus turn-outs, other stop amenities.

CO₂ Reduction

4,400 tons/yr in 2010.

Target Sector

Transportation

Sector Penetration

N/A

Implementation Costs

N/A

Savings (\$/yr in 2010)

Energy	\$681,000
Avoided driving	7,818,000
Avoided CO ₂ damage	219,000
	<u>\$8,718,000</u>

Economic Impacts

Increased personal savings from reduced driving.

Implementation Responsibilities

Primary:	Planning Department
Support:	Public Works — Transit and Engineering.

Funding Options

N/A

Implementation Schedule

1996-2010; dependent on rate of new development and opportunities for redevelopment.

Measure 8 *Continued*

Implementation Steps

1. The Planning Department is already implementing this measure in several areas of the City, including Otay Ranch by utilizing the SANDAG Land-Use Distribution Element as a framework. The policy should continue to be incorporated into appropriate general plan updates, zone changes, and other applicable land-use standards.
2. The City should work with the APCD in developing its proposed indirect source rule whose objectives are consistent with CO₂ reduction.
3. The City should develop a transit-oriented development overlay zone for application to major transit centers.
4. The City should develop a transit-oriented development overlay zone for application to major transit centers.

Measure 9
INCREASED LAND-USE MIX

Description

Greater dispersion of a wide variety of land-uses generally; siting of neighborhood commercial uses in residential areas; inclusion of housing in commercial and light industrial areas.

CO₂ Reduction

8,700 tons/yr in 2010.

Target Sector

Transportation

Sector Penetration

N/A

Implementation Costs

N/A

Savings (\$/yr in 2010)

Energy	\$1,361,000
Avoided driving	15,636,000
Avoided CO ₂ damage	<u>437,000</u>
	\$17,434,000

Economic Impacts

Support for small neighborhood businesses; increased personal savings from reduced driving.

Implementation Responsibilities

Primary: Planning Department
Support: Public Works and Community Development

Funding Options

N/A

Implementation Schedule

1996-2010; dependent on rate of new development and opportunities for redevelopment.

Measure 9 *Continued*

Implementation Steps

1. The Planning Department is already implementing this measure in several areas of the City, including Otay Ranch by utilizing the SANDAG Land-Use Distribution Element as a framework. The policy should continue to be incorporated into appropriate general plan updates, zone changes, and other applicable land-use standards.
2. The City should work with the APCD in developing its proposed indirect source rule whose objectives are consistent with CO₂ reduction.

7. CO₂ Reduction Plan Implementation and Action Measures

Measure 10

GREEN POWER PUBLIC EDUCATION PROGRAM

Replaced Reduced Commercial Parking Requirements June 1998

In June 1998 staff was directed to develop a public education program for Chula Vista residents. The program provided information about renewable power choices specifically relating to green power. Information was published in the local newspaper, sent with trash bills and is still today provided at various special events. In the future that information will be available on the City's web site where it can be updated and linked to information regarding other CO₂ reduction options from their home and business. In addition, a global warming education module has been successfully implemented in the Chula Vista Elementary School District. This module educates elementary aged school children about the harmful effects of CO₂ in the atmosphere.

Measure 10

REDUCED COMMERCIAL PARKING REQUIREMENTS

Description

Lower parking space requirements; allowance for shared lots and shared parking; allowance for on-street spaces.

CO₂ Reduction

6,300 tons/yr in 2010.

Target Sector

Transportation

Sector Penetration

N/A

Implementation Costs

N/A

Savings (\$/yr in 2010)

Energy	\$985,000
Avoided driving	11,315,000
Avoided CO ₂ damage	<u>316,000</u>
	\$12,616,000

Economic Impacts

Increased personal savings from reduced driving through encouraging the use of transit.

Implementation Responsibilities

Planning and Community Development Departments.

Funding Options

N/A

Implementation Schedule

1996-2010; dependent on rate of new development and opportunities for redevelopment.

Measure 10 *Continued***Implementation Steps**

1. The Planning Department is already implementing this measure in several areas of the City, including Otay Ranch by utilizing the SANDAG Land-Use Distribution Element as a framework. The policy should continue to be incorporated into appropriate general plan updates, and eventually the citywide parking standards. An example of transit-oriented parking ratios that should be considered is as follows:

<u>Land Use</u>	<u>Off-Street Parking Spaces Required</u>		
	<u>City Standard</u>	<u>% of City Standard</u>	
		<u>Within One Block of Transit</u>	<u>Within ¼ mi. Of Transit</u>
Residential	1.8 ^(a)	78	89
Office	3.0 ^(b)	87	93
Retail	4.0 ^(b)	88	94

(a) Spaces per dwelling unit

(b) Spaces per 1,000 sq.ft. of building area.

2. The City should work with the APCD in developing its proposed indirect source control rule whose objectives are consistent with CO₂ reduction.

Measure 11

SITE DESIGN WITH PEDESTRIAN/BICYCLE ORIENTATION

Description

Placement of buildings and circulation routes to emphasize pedestrian and bicycle access without excluding autos; includes pedestrian benches, bike paths, bike racks.

CO₂ Reduction

4,300 tons/yr in 2010.

Target Sector

Transportation

Sector Penetration

N/A

Implementation Costs

N/A

Savings (\$/yr in 2010)

Energy	\$681,000
Avoided driving	7,818,000
Avoided CO ₂ damage	<u>219,000</u>
	\$8,718,000

Economic Impacts

Increased personal savings from reduced driving.

Implementation Responsibilities

Planning and Public Works Departments

Funding Options

N/A

Implementation Schedule

1996-2010; dependent on rate of new development and opportunities for redevelopment.

Measure 11 *Continued*

Implementation Steps

1. The Planning Department is already implementing this measure in several areas of the City, including Otay Ranch by utilizing the SANDAG Land-Use Distribution Element as a framework. The policy should continue to be incorporated into appropriate design reviews conditional use permits, and other applicable land-use standards.

Measure 12

BICYCLE INTEGRATION WITH TRANSIT AND EMPLOYMENT

Description

Bike storage at major transit stops, employment areas. Encourage employers to provide showers at major transit nodes. Bike racks on buses.

CO₂ Reduction

2,400 tons/yr in 2010.

Target Sector

Transportation

Sector Penetration

N/A

Implementation Costs

Approximately \$125,000 (\$25,000/yr over 5 years) in capital costs; \$5,000/yr O&M costs.

Savings (\$/yr in 2010)

Energy	\$376,000
Avoided driving	4,321,000
Avoided CO ₂ damage	<u>121,000</u>
	\$4,818,000

Economic Impacts

Increased personal savings from reduced driving.

Implementation Responsibilities

Joint working group that includes the Planning and Public Works Departments.

Funding Options

A,B,D,E,F

Implementation Schedule

1996-2001.

Measure 12 *Continued*

Implementation Steps

1. Convene a working group of City staff to identify key sites for bicycle integration improvements, such as showers and locked storage.
2. Survey other transit system experiences with bicycle racks and select appropriate racks for the City transit system.
3. Assemble funding.
4. Prioritize and initiate site-specific improvements and bus rack installations. Bike storage facilities should be prioritized for installation at major trip destinations, such as Southwestern College.

Measure 13

BICYCLE LANES, PATHS, AND ROUTES

Description

Continued implementation of the City's bicycle master plan, including installation of seven miles of lanes/routes annually (amount needed to complete the bike plan by 2010). Emphasis is to be given to separate bike paths as opposed to striping bike lanes on streets.

CO₂ Reduction

1,447 tons/yr in 2010.

Target Sector

Transportation. Sixty-one miles out of a total 154 mile bicycle system currently exist.

Sector Penetration

An additional 93 miles of lanes/routes would be added to complete 100% of the bicycle master plan.

Implementation Costs

Approximately \$5.4 million in total 1996-2010 construction costs. Implementation costs are expected to be shared with the City of San Diego and San Diego County.

Savings (\$/yr in 2010)

Energy	\$255,728
Avoided driving	2,592,425
Avoided CO ₂ damage	72,361
	<u>\$2,920,514</u>

Economic Impacts

Increased personal savings from reduced driving.

Implementation Responsibilities

Primary: Public Works Department
Support: Parks & Recreation and Planning Departments

Funding Options

A,B,E,F,J,M

Implementation Schedule

1996-2010.

Measure 13 *Continued*

Implementation Steps

1. This measure is a continuation of an ongoing effort by the City to complete the full system of lanes and routes in its bicycle master plan. Emphasis should be given to bike path integration in the Greenbelt and Otay Ranch master plans.
2. Routes to be improved should be selected in coordination with other land-use/transportation measures in order to strengthen the overall impact on auto driving and CO₂ emissions. For example, routes that lead to the bicycle integration projects under Measure 12 should be prioritized for action.
3. Encourage planning for separate bike paths as opposed to bike lane striping of streets in new development.

Measure 14

ENERGY EFFICIENT LANDSCAPING

Description

Installation of shade trees for new single-family home as part of an overall city-wide tree-planting effort to reduce ambient temperatures, smog formation, energy use, and CO₂.

CO₂ Reduction

1,300 tons/year in 2010.

Target Sector

Residential (new construction)

Sector Penetration

75% of all new homes built during 1996-2010, or about 11,500 dwellings.

Implementation Costs

Approximately \$867,000 in total installation and first-year maintenance costs.

Savings (\$/yr 2010)

Energy	\$219,000
Avoided CO ₂ damage	64,000
	<u>\$283,000</u>

Economic Impacts

Increased personal savings from reduced energy expenses.

Implementation Responsibilities

Primary: Building and Parks Departments
Support: Planning Department

Funding Options

A,B,F,H,J,M

Implementation Schedule

1996-2010; dependent on rate of new development and opportunities for redevelopment.

Measure 14 *Continued*

Implementation Steps

1. Over and above the City's existing landscape requirements, this measure would offer shade trees for new single-family dwellings. The trees would be provided through an urban forestation fund, with installation and maintenance being the responsibility of the builder/owner.
2. The urban forestation fund would be capitalized from the sources listed on the previous page.
3. The program would be administered by the Building and Parks Departments, with assistance from the Planning and Public Work Departments.
4. The tree-planting effort should also extend to municipal and other public open spaces (street medians, etc.) in order to reduce smog creation, energy expenses, and CO₂ citywide.
5. The residential program should include an annual award component that recognizes exemplary efforts toward CO₂-efficient landscaping.

Measure 15
SOLAR POOL HEATING

Description

Mandatory building code requirement for solar heating of new pools or optional motorized insulated pool cover.

CO₂ Reduction

2,500 tons/yr in 2010.

Target Sector

Residential. Approximately 50 new pools are built per year. This should rise to 65 per year by 2010.

Sector Penetration

100% of new pool construction.

Implementation Costs

Approximately \$1.2 million in total 1996-2010 incremental construction costs. O&M is assumed to be cost-neutral. About \$10,000 in staff labor would be required to amend the code for this measure.

Savings (\$/yr in 2010)

Energy	\$380,000
Avoided CO ₂ damage	<u>123,000</u>
	\$503,000

Economic Impacts

Increased personal savings from lower energy bills.

Implementation Responsibilities

Building Department

Funding Options

A,B,F,G,H

Implementation Schedule

Code amendment in 1996; becomes effective 1997-2010.

Measure 15 *Continued*

Implementation Steps

1. Convene a working group of City staff and interested local building professionals to draft the desired code amendment.
2. Process the code amendment through City Council adoption.
3. Conduct a public information effort to inform citizens and builders of the new solar heating requirement, and offer technical assistance in cooperation with stakeholder organizations.
4. Monitor installed systems to evaluate energy and CO₂ impacts.

Measure 16

TRAFFIC SIGNAL & SYSTEM UPGRADES

Description

Retrofitting of signals with high-efficiency LED lamps. These lamps are not yet approved by Caltrans, but current testing elsewhere in California may allow their use in the near future. Also, implementation of a signal automation and timing program modeled after Toronto's SCOOT program.

CO₂ Reduction

1,640 tons/yr in 2010.

Target Sector

Municipal government. There are currently 7,200 traffic signal lamps in the City.

Sector Penetration

100% of signal lamps.

Implementation Costs

Approximately \$2 million in total 1996-2010 incremental costs for lamp purchases and signal automation/timing improvements.

Savings (\$/yr in 2010)

Energy	\$21,000
Avoided CO ₂ damage	<u>6,000</u>
	\$27,000

Fiscal and Economic Impacts

Lower municipal and private driver energy expenses; and reduced global warming damage costs.

Implementation Responsibilities

Public Works Department

Funding Options

B,F,H,I,M

Implementation Schedule

Already ongoing; 100% will be retrofitted in 2002 if the LED light is approved by Caltrans in 1996.

Measure 16 *Continued*

Implementation Steps

1. Part of this program is an ongoing effort where the City is already replacing older lamps with newer, more efficient lamp units.
2. The Light Emitting Diode (LED) lamp pilot program is proposed to implement the next generation of energy-efficient lamps. This consists of tracking tests conducted by the City of San Louis Obispo and other cities using LED's and identifying three intersections to fully utilize LED's in Chula Vista, tracking energy and labor savings. If pilot is deemed successful, implement complete changeout to LED's by 2010 or provide similar schedule to Council. Staff is aware of and following the Caltrans test to determine if and when Chula Vista can start using LED lamps.
3. City staff will also be shortly implementing a signal automation/timing program modeled after Toronto's SCOOT program.

Measure 17

STUDENT TRANSIT SUBSIDY

Description

Encourage transit subsidies to mitigate new development related to area impact.

CO₂ Reduction

3,900 tons/yr in 2010.

Target Sector

Transportation. There are an estimated 30,000 post-secondary students currently attending schools in Chula Vista.

Sector Penetration

The subsidy would be made available to 100% of students; 22% are assumed to use it (6,600 students).

Implementation Costs

Approximately \$800,000/yr.

Savings (\$/yr in 2010)

Energy	\$605,000
Avoided driving	6,948,000
Avoided CO ₂ damage	<u>194,000</u>
	\$7,747,000

Economic Impacts

Increased personal income and resulting savings from reduced driving.

Implementation Responsibilities

Primary: Post-secondary schools
Support: CO₂ program and City transit

Funding Options

A,B,D,F,G,I,M

Implementation Schedule

1996-2010.

Measure 17 *Continued*

Implementation Steps

1. Convene a working group of Chula Vista post-secondary schools and City staff to build a partnership and detail the structure of the desired transit subsidy. This effort would be coordinated with related activities at MTDB, APCD, UCSD, and other organizations.
2. Further subsidy should be funded by schools. Public information on subsidies will be associated with transit maps and schedules, and will describe subsidies available to students. Public information materials will be distributed to the public at large.
3. Assemble funding for subsidies based on contributions from the sources listed on the previous page.
4. Implement and monitor participation and savings.

7. CO₂ Reduction Plan Implementation and Action Measures

Measure 18

ENERGY EFFICIENT BUILDING RECOGNITION PROGRAM

GREENSTAR BUILDING PROGRAM

The Energy Efficient Building Program reduces carbon dioxide emissions by developing building programs that are a minimum of 20% more energy efficient than Title 24 Energy Code requirements. Builders are encouraged to voluntarily incorporate energy efficient features in their projects and are rewarded for their commitment with priority permit processing and recognition awards. This program also known as the "GreenStar" Building Incentive Program requires third party energy inspections and CO₂ measurements to gauge the success of the program once completed.

Measure 18

ENERGY EFFICIENT BUILDING RECOGNITION PROGRAM

Description

This measure includes encouragement for builders to voluntarily incorporate efficiency features in their projects, and rewards them with "energy star" or comparable recognition and lower permit fees. The objective is recognizing exemplary buildings and promoting their marketability. The program would apply to residential and nonresidential new construction and remodels.

CO₂ Reduction

15,600 tons/yr in 2010.

Target Sectors

Residential and commercial.

Sector Penetration

50% of new construction and remodeling projects are assumed to participate in the program once fully implemented. This equates to approximately 9,000 homes and 4.5 million sq. ft. of commercial building space by 2010.

Implementation Costs

Approximately \$20,000 start-up; \$30,000/yr operation.

Savings (\$/yr in 2010)

Energy	\$2,664,000
Avoided CO ₂ damage	<u>780,000</u>
	\$3,444,000

Economic Impacts

Increased business savings that will be passed along to the buyer/homeowner; increased personal savings from lower energy bills; stimulus for efficiency measure vendors and installers; and local job creation.

Implementation Responsibilities

Primary: Building Department
Support: CO₂ program

Funding Options

A,B,F,G,H,J,M

Implementation Schedule

1996-2010.

Measure 18 *Continued*

Implementation Steps

1. Convene a working group of City staff to review established programs in other jurisdictions. There are also guidebooks available explaining how to establish new programs. It is also strongly recommended that City staff talk with other jurisdiction staff that have had experience administering such programs; some communities have found it cumbersome to administer complex “energy star” programs, and can provide helpful advice on avoiding administrative headaches.
2. Formulate a recognition program that fits Chula Vista’s capabilities and circumstances. Initially it is recommended that a simplified checklist approach be taken, using the type of efficiency criteria listed in Table 4.4, Chapter 4. The intent would be a plan review that scores the qualitative presence of a feature rather than its precise quantitative characteristics. Once the program has some operating experience, the stakeholders can, if desired, increase the quantitative precision of scoring efficiency and awarding recognition.
3. Assemble and develop information and promotional materials for distribution to citizens and builders. Conduct a media and speaking campaign to announce the program; and importantly, to encourage discussion of the issues among the buying public and designers/builders.
4. Designate appropriate Building Department plan review staff to review efficiency information with permittees.
5. Designate appropriate staff to review plans and assign a “recognition score” as appropriate.
6. Provide builders/owners with recognition certification; conduct annual beautification awards; and incorporate success stories into the City’s overall efficiency marketing effort.
7. Monitor participating building performance to evaluate energy and CO₂ savings.

Measure 19

MUNICIPAL LIFE-CYCLE PURCHASING STANDARDS**Description**

Inclusion of life-cycle energy costs as a selection criterion in a comprehensive purchasing policy for energy-consuming equipment. Such equipment includes vehicles, copy machines, computers, and motor-driven devices. Where applicable, equipment should be Energy Star compliant, and Energy Star guidelines should be incorporated in bid solicitation documents. The scope of this measure should also extend to new construction and remodeling of municipal buildings.

CO₂ Reduction

10,000 tons/yr in 2010.

Target Sector

Municipal government

Sector Penetration

100% of applicable equipment purchases.

Implementation Costs

Approximately \$100,000/yr in incremental costs for premium efficiency models (20% higher than baseline models). Conducting life-cycle evaluations is estimated at \$5,000/yr.

Savings (\$/yr in 2010)

Energy	\$1,730,000
Avoided CO ₂ damage	<u>508,000</u>
	\$2,238,000

Fiscal and Economic Impacts

Reduced municipal expenses; reduced air quality/global warming damage costs.

Implementation Responsibilities

Primary: All City departments
Secondary: CO₂ program

Funding Options

C,F,G,H,M

Implementation Schedule

1996-2010.

Measure 19 *Continued*

Implementation Steps

1. Review life-cycle purchasing standards from other jurisdictions. There are also several guidebooks available that explain how to establish life-cycle purchasing. Santa Barbara County is currently completing a national demonstration project that could provide a useful model for Chula Vista.
2. Process City Council adoption of a policy involving all departments to life-cycle evaluations.
3. Acquire or prepare spreadsheet software for conducting life-cycle energy evaluations.
4. Initiate use of evaluations during normal procurement.
5. Monitor equipment purchases and performance to evaluate energy and CO₂ savings.
6. Share results of municipal purchase evaluations with other public agencies and local businesses.

Measure 20

INCREASED EMPLOYMENT DENSITY NEAR TRANSIT

Description

General increase in land-use and zoning designations to focus employment-generating land-uses within quarter mile of major transit stops throughout the City.

CO₂ Reduction

13,355 tons/yr in 2010.

Target Sector

Transportation.

Sector Penetration

N/A

Implementation Costs

N/A

Savings (\$/yr in 2010)

Energy	\$2,079,343
Avoided driving	23,880,688
Avoided CO ₂ damage	<u>667,736</u>
	\$26,627,767

Economic Impacts

Increased personal and business savings from reduced driving.

Implementation Responsibilities

Planning, Public Works, and Community Development Departments.

Funding Options

L

Implementation Schedule

1996 - 2010; dependent upon rate of new development and opportunities for redevelopment.

Measure 20 Continued

Implementation Steps

1. The Planning Department is already implementing this measure in several areas of the City, including Otay Ranch by utilizing the SANDAG land-use distribution element as a framework. The policies should continue to be incorporated into appropriate general plan updates, zone changes, and other applicable land-use standards.
2. The City should work with the APCD in developing its proposed indirect source control program whose objectives are consistent with CO₂ reduction.
3. The City should develop a transit-oriented development overlay zone for application to major transit centers.

1. Municipal Clean Fuel Vehicle Purchase

Cap. Cost(\$)	O & M Cost (\$/yr.)	VMT Saved (miles/yr.)	Energy (MMBTU/yr.)	Energy saved (\$/yr.)	CO2 (Tons/yr.)	Payback(yrs)	Ext. CO2 Saved (\$)	Ext. VMT Saved (\$)
661,214	0	0	1,838	36,010	251	18.4	12,561	0

Assumptions

1. Conversion percentages
Conversion percentages to achieve 70% penetration by 2010(except police cars)

CNG	50
M85	10
Electric	10
Diesel	0
Total	70

Note that police cars have not been included in the conversion, for conservatism.
Diesel vehicles have not been converted, because of no conversion plans.
2. Paybacks are calculated based on fuel savings achieved.
3. Savings are calculated for total fleet conversion.
4. 2010 fleet calculations are done by increasing the 1995 share on a per capita basis.
5. 1995 fleet -336 vehicles, 2010 fleet 391, and number of cars converted by 2010 is 185.(excluding police, diesel and gasoline cars.)
6. Average age of Chula Vista municipal fleet is 1991, hence the fleet will be fully replaced by 2004, if the replacement starts in 1996.
7. Average cost of nonelectric cars are 20,500 and average cost of electric cars were 32,000 for the year 2010.(Source CEC Transportation Energy Analysis)
8. Literature indicates that maintenance costs of CNG and Electric vehicles are less than that of gasoline vehicles, where as , M85 could cost more for maintenance. On an average no credit is given for decreased maintenance costs, because of uncertainty.

2. General Fleet Operator Clean Fuel Purchase Commitments

Capital Cost (\$)	O&M Cost (\$/Yr)	VMT Saved (Miles/Yr)	Energy (MMBTU/Yr)	Energy Saved (\$/Yr)	CO ₂ (Tons/Yr)	Payback (Yrs)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
6,185,618	0	0	23,806	643,402	3,471	9.6	173,567	0

Assumptions:

- Conversion percentages:
Conversion percentages for cars except police cars:
CNG 60
M85 15
Electric 15
Gasoline 10
Diesel 0
Total 100
Diesel vehicles have not been converted, because of no conversion plans.
- Paybacks are calculated based on fuel savings achieved.
- Savings are calculated for total fleet conversion.
- 2010 fleet calculations are done by increasing the 1995 share on increase in square feet of commercial space.
- 1994 fleet - 1,833 vehicles, 2010 fleet - 4,033 - vehicles, and number of cars converted by 2010 is 1,644.
- Percentages of gasoline (45%), and diesel vehicles (55%) estimated from Transportation Energy Data Book, ORNL, 1994 (pages 3-48).
- Vehicle replacement averages were obtained from Transportation Energy Data Book, ORNL, 1994 (pages 3-48).
- Given a vehicle replacement average of 35-56 months, total fleet would be converted by 2001, if replacement starts in 1996.
- Average cost of non-electric car - \$20,500 and electric car - \$32,000 for 2010 (source CEC Transportation Energy Analysis).
- Literature indicates that maintenance costs of CNG and electric vehicles are less than that of gasoline vehicles, where as, M85 could cost more for maintenance. On average no credit is given for decreased maintenance costs, because of uncertainty.

3. High Visibility Clean Fuel Demonstration Projects

Capital Cost (\$)	O&M Cost (\$/Yr)	VMT Saved (Miles/Yr)	Energy (MMBTU/Yr)	Energy Saved (\$/Yr)	CO ₂ (Tons/Yr)	Payback (Yrs)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
7,000,000	3,000,000	0	34,022	N/A	2,722	N/A	21,012	0

Assumptions:

- CO₂ savings are based on the fact that 303,000 VMT would have to be born by diesel buses.
- Three new buses will replace existing 1984 6V92 diesel engines and two new hydrogen buses will be added.

4. Telecommuting and Telecenters

Capital Cost (\$)	O&M Cost (\$/Yr)	VMT Saved (Miles/Yr)	Energy (MMBTU/Yr)	Energy Saved (\$/Yr)	CO ₂ (Tons/Yr)	Payback (Yrs)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
100,000	240,000	923,140	4,823	67,650	367	0.57	18,327	655,429

Assumptions:

1. Cost and payback is calculated for city assuming that a telecenter generates an annual revenue of \$5,000/month.
2. It is assumed that there would be 2 telecenters operating by 2010.
3. It is assumed telecommuting save 0.3 trips/day/person, 20 miles/trip, 261 days/year (Ref. - Inventory and Review of TDM Measures, pages 2-7, Section II-C, ITE).
4. It is assumed that total occupancy is 90 per center.
5. Assume \$350/occupant/year expenditure/customer (Ref. - Inventory and Review of TDM Measures, pages 2-7, Section II-C, ITE).
6. It is assumed that by 2010, telecenters will achieve 75% occupancy.
7. It is assumed that by 2010, that there will be 500 telecommuters.
8. The percentage of people who use telecenters and telecommute constitute 1.9% of the total workforce in Chula Vista in 2010.
9. Average area of each telecenter would be 1,500 square feet.
10. Capital cost of \$50,000/telecenter to set it up.
11. Each telecenter costs \$10,000/month to run (including salary, rent, and other expenses). (ref. - Council Agenda Statement, Chula Vista)
12. Two telecenters save 140,140 miles/yr based on City of Chula Vista memo, Feb 96.

5. Municipal Buildings and Employee Commuting

	Cap. Cost (\$)	O & M Cost (\$/yr.)	VMT Saved (miles/yr.)	Energy (MMBTU/yr.)	Energy saved (\$/yr.)	CO ₂ (Tons/yr.)	Payback (yrs)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
Mun. buildings	247,900	0	0	4,692	138,500	692	1.79	34,580	0
Emp. commuting	258,148	4,610	264,915	1,354	18,987	107	N/A	5,362	188,090

1. There are 29 municipal buildings in the City of Chula Vista (Communication with George Kreml, City of Chula Vista, 3/11/96)
2. There is a total of 415,000 sq.ft. of municipal building space in City of Chula Vista (Communication with George Kreml, City of Chula Vista, 3/11/96)
3. It is assumed that in the next 14 years there would be further retrofit of the city buildings.
4. There are 855 employees in City of Chula Vista and 60 of them can telecommute.(Communication with George Kreml, City of Chula Vista, 3/11/96)
5. Of the 60 employees, it is assumed that 30 employees will actually telecommute.
6. It is assumed that telecommuting saves 0.3 trips/day/person, 20 miles/trip, 261 days/year. (Ref:- Inventory and Review of TDM Measures Pg 2-7 Section II-C, ITE)
7. Cost of a van is assumed to be \$23,468 in the year 2010.(Ref:Table 2A-8 of CEC Transportation Energy Analysis)
8. It is assumed that 100 employees vanpool and it saves 10 miles/day/person.
9. It is assumed that 9 employees travel in a van and van travels 15 miles/day.

6. Pedestrian-Transit Connection

Capital Cost (\$)	O&M Cost (\$/Yr)	% Reductions		VMT Reductions		VMT Saved (Miles/Yr)	Energy (MMBTU/Yr)	Energy Saved (\$/Yr)	CO ₂ (Tons/Yr)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
		1990 VMT	1990-2010 VMT	1990 VMT	1990-2010 VMT						
0	0	0.75	1.75	7,808,128	8,128,377	15,936,505	83,258	985,214	6,328	316,380	11,314,919

Assumption:

1. VMT reduction based on collective research on Dagang, 1995; Cervero, 1994; Holtzclaw, 1994; and Frank, 1994.

7. Housing Density at Transit

Capital Cost (\$)	O&M Cost (\$/Yr)	% Reductions		VMT Reductions		VMT Saved (Miles/Yr)	Energy (MMBTU/Yr)	Energy Saved (\$/Yr)	CO ₂ (Tons/Yr)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
		1990 VMT	1990-2010 VMT	1990 VMT	1990-2010 VMT						
0	0	1.00	2.50	10,410,838	11,611,968	22,022,805	115,055	1,361,477	8,744	437,209	15,636,192

Assumption:

1. VMT reduction based on collective research on Dagang, 1995; Cervero, 1994; Holtzclaw, 1994; and Frank, 1994.

8. Transit Oriented Sites

Capital Cost (\$)	O&M Cost (\$/Yr)	% Reductions		VMT Reductions		VMT Saved (Miles/Yr)	Energy (MMBTU/Yr)	Energy Saved (\$/Yr)	CO ₂ (Tons/Yr)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
		1990 VMT	1990-2010 VMT	1990 VMT	1990-2010 VMT						
0	0	0.50	1.25	5,205,419	5,805,984	11,011,403	57,527	680,738	4,372	218,604	7,818,096

Assumption:

1. VMT reduction based on collective research on Dagang, 1995; Cervero, 1994; Holtzclaw, 1994; and Frank, 1994.

9. Mixed Use

Capital Cost (\$)	O&M Cost (\$/Yr)	% Reductions		VMT Reductions		VMT Saved (Miles/Yr)	Energy (MMBTU/Yr)	Energy Saved (\$/Yr)	CO ₂ (Tons/Yr)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
		1990 VMT	1990-2010 VMT	1990 VMT	1990-2010 VMT						
0	0	1.00	2.50	10,410,838	11,611,968	22,022,805	115,055	1,361,477	8,744	437,209	15,636,192

Assumption:

1. VMT reduction based on collective research on Dagang, 1995; Cervero, 1994; Holtzclaw, 1994; and Frank, 1994.

10. Reduced Parking

Capital Cost (\$)	O&M Cost (\$/Yr)	% Reductions		VMT Reductions		VMT Saved (Miles/Yr)	Energy (MMBTU/Yr)	Energy Saved (\$/Yr)	CO ₂ (Tons/Yr)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
		1990 VMT	1990-2010 VMT	1990 VMT	1990-2010 VMT						
0	0	0.75	1.75	7,808,128	8,128,377	15,936,505	83,258	985,214	6,328	316,380	11,314,919

Assumption:

1. VMT reduction based on collective research on Dagang, 1995; Cervero, 1994; Holtzclaw, 1994; and Frank, 1994.

11. Pedestrian/Bicycle Orientation

Capital Cost (\$)	O&M Cost (\$/Yr)	% Reductions		VMT Reductions		VMT Saved (Miles/Yr)	Energy (MMBTU/Yr)	Energy Saved (\$/Yr)	CO ₂ (Tons/Yr)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
		1990 VMT	1990-2010 VMT	1990 VMT	1990-2010 VMT						
0	0	0.50	1.25	5,205,419	5,805,984	11,011,403	57,527	680,738	4,372	218,604	7,818,096

Assumption:

1. VMT reduction based on collective research on Dagang, 1995; Cervero, 1994; Holtzclaw, 1994; and Frank, 1994.

12. Bicycle with Employment/Shops

Capital Cost (\$)	O&M Cost (\$/Yr)	% Reductions		VMT Reductions		VMT Saved (Miles/Yr)	Energy (MMBTU/Yr)	Energy Saved (\$/Yr)	CO ₂ (Tons/Yr)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
		1990 VMT	1990-2010 VMT	1990 VMT	1990-2010 VMT						
125,000	5,000	0.25	0.75	2,602,709	3,483,590	6,086,300	31,797	376,262	2,417	120,829	4,321,273

Assumption:

- VMT reduction based on collective research on Dagang, 1995; Cervero, 1994; Holtzclaw, 1994; and Frank, 1994.

13. Commuter Bike Lanes/Routes

Cap. Cost(\$)	O & M Cost (\$/yr.)	VMT Saved (miles/yr.)	Energy (MMBTU/yr.)	Energy saved (\$/yr.)	CO2 (Tons/yr.)	Payback (yrs)	Ext. CO2 Saved (\$)	Ext. VMT Saved (\$)
5,417,000	0	3,651,303	19,076	225,728	1,447	"N/A"	72,361	2,592,425

Assumptions:

- It is assumed that this measure produces 0.24% savings in total VMT.(Consistent with SANDAG TCM Plan)
- It is assumed that bike lanes and routes cost a total of \$5,417,000. (Consistent with Chula Vista Bikeway Master Plan)
- 61 miles of bike lanes and routes have been built and by 2010 it is assumed that there would be additional 93 miles built.(consistent with the Chula Vista Bikeway Master Plan.)

14. Site Design With Energy-Efficient Landscaping

Capital Cost (\$)	O&M Cost (\$/Yr)	VMT Saved (Miles/Yr)	Energy (MMBTU/Yr)	Energy Saved (\$/Yr)	CO ₂ (Tons/Yr)	Payback (Yrs)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
866,668	0	0	8,674	218,500	1,279	3.97	63,931	0

Assumptions:

- Savings are calculated on new single-family dwelling units only.
- It is assumed that 75% of dwelling units will receive energy efficient landscaping.
- Landscaping is achieved by planting three trees.
- It is assumed that a 220 kWh reduction in space conditioning load could be achieved (ref. - Energy Efficiency and Environment: Forging the Link, page 361).
- Total number of new residences that receive landscaping would be 11,500.

15. New Pool With Solar Heater

Capital Cost (\$)	O&M Cost (\$/Yr)	VMT Saved (Miles/Yr)	Energy (MMBTU/Yr)	Energy Saved (\$/Yr)	CO ₂ (Tons/Yr)	Payback (Yrs)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
1,260,000	0	0	42,394	379,847	2,462	3	123,111	0

Assumptions:

1. It is assumed that an average of 50 permits would be issued each year.
2. It is assumed that a natural gas system would cost \$2,000 and a solar system would cost \$2,800.
3. It is assumed that 50% of the residents would still buy gas back-up systems for their Jacuzzi units.
4. It is assumed that an average home consumes 757 therms to heat the pool (ref. - San Diego Air Pollution Control District, CEC DEER database).
5. It is assumed that back-up units consume 151 therms to heat the pool/Jacuzzi (ref. - San Diego Air Pollution Control District).

16. Traffic Signal Improvements

	Cap. Cost (\$)	O & M Cost (\$/yr.)	VMT Saved (miles/yr.)	Energy (MMBTU/yr.)	Energy saved (\$/yr.)	CO ₂ (Tons/yr.)	Payback (yrs)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved(\$)
LED traffic signals	53,667	0	0	275	6,922	41	7.75	2,025	0
Signalization	2,000,000	0	0	21,082	249,469	1,599	N/A	79,971	0

Assumptions:

1. It is assumed that only red traffic lamps are going to be retrofitted with LED lamps.
2. The cost of LED lamps are based on a 10 year average life.
3. For more information on LED traffic signals refer to E SOURCE INC, TU-94-1
4. LED lamps provide excellent maintenance savings since they have a life of 10 years, but they are not included in the savings.
5. Total number of traffic lamps in Chula Vista is 7236, but only a third of them can be replaced.
6. It is assumed that 400 lamps will be replaced every year, hence the replacements will be complete by 2002 starting in 1996 pending CALTRANS approval.
7. Since traffic volumes through each intersection were not available, it is assumed that traffic volume through intersections is 50% less than Toronto.
(Note:- This is to account for the lesser traffic volumes in Chula Vista as compared to Toronto.)(Ref:- SCOOT Demonstration Project, Toronto)
8. Cost of signalization is 2,000,000. (Source:- memo from Bamberger, Feb 96)

17. Student Transit Subsidies

Capital Cost (\$)	O&M Cost (\$/Yr)	VMT Saved (Miles/Yr)	Energy (MMBTU/Yr)	Energy Saved (\$/Yr)	CO ₂ (Tons/Yr)	Payback (Yrs)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
0	792,000	9,786,156	51,126	604,992	3,879	N/A	193,940	6,948,171

Assumptions:

1. Assume 30,000 students are available for transit subsidy (Chula Vista fax dated August 22, 1995).
2. Assume \$10/student participated is spent on transit subsidy.
3. Assume total savings of 0.65% (consistent with SANDAG TCM plan).
4. Assumes that 22% (6,600 students) will be using the transit subsidy by 2010 (SANDAG TCM plan).

18. "Energy Star" Energy Efficient Building Incentive Program

Capital Cost (\$)	O&M Cost (\$/Yr)	VMT Saved (Miles/Yr)	Energy (MMBTU/Yr)	Energy Saved (\$/Yr)	CO ₂ (Tons/Yr)	Payback (Yrs)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
0	30,000	0	105,775	2,664,477	15,592	N/A	779,596	0

Assumptions:

1. It is assumed that 10% savings in new residential energy consumption and 5% savings in new commercial buildings is achievable.
2. It is assumed that 20% savings in existing residential energy consumption and 10% savings in existing commercial buildings is achievable.
3. It is assumed that 50% penetration in new buildings and retrofits is achieved.
4. It is assumed that 20% of residential and commercial buildings will be retrofitted between 1995 and 2010.
5. Number of new residences - 18,638 and new commercial space by 2010 is 9.3 million square feet.
6. 6,679 old residences and 2.2 million square feet of commercial buildings receive retrofit by 2010.

19. Municipal Life Cycle Purchasing Standards

Capital Cost (\$)	O&M Cost (\$/Yr)	VMT Saved (Miles/Yr)	Energy (MMBTU/Yr)	Energy Saved (\$/Yr)	CO ₂ (Tons/Yr)	Payback (Yrs)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
100,000	5,000	0	68,869	1,729,994	10,152	0.058	507,587	0

Assumptions:

1. Cost of software, training, and labor is assumed to cost \$5,000/year.
2. It is assumed that the base case efficiency of equipment is 70% and implementing standards increase this to 80%.
3. Energy savings are calculated from estimating equipment load off the municipal building energy consumption.
4. Total municipal office equipment budget is assumed to be \$500,000 and energy efficient equipment is assumed to cost 20% more.

Example #1

Laser printer (conventional) 190 kWh/year
 Laser printer (efficient) 160 kWh/year
 Savings 16%
 (ref. - Guide to Energy-Efficient Office Equipment ACEEE, 1993, page 8)

Example #2

Copier (on 9 hours/day) 600 kWh/year
 Copier (with energy saver feature - on 9 hours/day) 500 kWh/year
 Savings 17%
 (ref. - Guide to Energy-Efficient Office Equipment ACEEE, 1993, page 9)

Example #3

Laser facsimile machines 340 kWh/year
 Inkjet facsimile machines 140 kWh/year
 Savings 59%
 (ref. - Guide to Energy-Efficient Office Equipment ACEEE, 1993, page 56)

Since the savings are generally higher than 10%, to be conservative it is assumed that the efficiency increases from 70-80%.

20. Employment Density Near Transit

Capital Cost (\$)	O&M Cost (\$/Yr)	% reductions		VMT reductions		VMT saved (miles/yr)	Energy (MMBTU/yr)	Energy saved (\$/yr)	CO ₂ (Tons/yr)	Ext. CO ₂ Saved (\$)	Ext. VMT Saved (\$)
		1990 VMT	1990-2010 VMT	1990 VMT	1990-2010 VMT						
0	0	1.00	5.00	10,410,838	23,223,935	33,634,773	175,720	2,079,343	13,355	667,736	23,880,688

Assumption:

1. VMT reduction based on collective research of Dagang, 1995; Cervero, 1994, Holtzclaw, 1994; and Frank, 1994.

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9. APPENDICES



Appendix A

EMISSION DATA SOURCES AND ASSUMPTIONS

Parameter	Value	Source
Lbs C emitted per gasoline production, MMBtu	7.8	CEC, CA Transportation Energy Analysis Report, 1994
Lbs C emitted per diesel production, 1 MMBtu	6.9	CEC, CA Transportation Energy Analysis Report, 1994
Lbs C emitted per methanol production, 1 MMBtu	9.5	CEC, CA Transportation Energy Analysis Report, 1994
Lbs C emitted per CNG production, 1 MMBtu	6.1	CEC, CA Transportation Energy Analysis Report, 1994
Lbs C emitted per LPG production, 1 MMBtu	6.9	CEC, CA Transportation Energy Analysis Report, 1994
Lbs C emitted per Elec of NG production, 1 KWh	0.130	CEC, CA Transportation Energy Analysis Report, 1994
Lbs C emitted per Elec of Coal production, 1 KWh	0.213	EPA, Methodologies for Estimating Greenhouse Gas Emissions, 1992
Lbs C emitted per Elec of Oil production, 1 KWh	0.171	EPA, Methodologies for Estimating Greenhouse Gas Emissions, 1992
Lbs C emitted per gasoline consumption, 1 MMBtu	41.8	CEC, CA Transportation Energy Analysis Report, 1994
Lbs C emitted per diesel consumption, 1 MMBtu	46.6	CEC, CA Transportation Energy Analysis Report, 1994
Lbs C emitted per Methanol consumption, 1 MMBtu	43.3	CEC, CA Transportation Energy Analysis Report, 1994
Lbs C emitted per CNG consumption, 1 MMBtu	34.7	CEC, CA Transportation Energy Analysis Report, 1994
Lbs C emitted per LPG consumption, 1 MMBtu	40.7	CEC, CA Transportation Energy Analysis Report, 1994
Lbs C emitted per electric consumption, 1 MMBtu	0.0	CEC, CA Transportation Energy Analysis Report, 1994
Lbs C emitted per 1E6 FT ³ of Vented Natural Gas	32,800.0	EPA, Methodologies for Estimating Greenhouse Gas Emissions, 1992
% CH ₄ of C emitted per 1E6 FT ³ of Vented Natural Gas	90.00%	EPA, Methodologies for Estimating Greenhouse Gas Emissions, 1992
Power Plant Load Factor	58.50%	SDG&E ER-94.
KWh/Year/Dwelling, San Diego, 1990	5,363	San Diego REP Demand & Supply Database
KWh/Year/sq.ft., San Diego, 1990	17	San Diego REP Demand & Supply Database
KWh/Year/Employee, San Diego, 1990	9,421	San Diego REP Demand & Supply Database
KWh/Year/Person, San Diego, 1990	584	San Diego REP Demand & Supply Database
KWh/Year/VMT, San Diego, 1990	0.0004	San Diego REP Demand & Supply Database
VMT/Person, San Diego, 1990	9,076	San Diego REP Demand & Supply Database
Commercial SQ.FT., San Diego, 1990	400,418,000	San Diego REP Demand & Supply Database
Persons, San Diego, 1990	2,520,500	San Diego REP Demand & Supply Database
Chula Vista 1990 Dwellings	49,849	Census
San Diego 1990 Dwellings	950,274	San Diego REP Demand & Supply Database
Chula Vista 1990 Persons	135,136	Census
Chula Vista 1990 Industrial Employees	13,362	Chula Vista Socioeconomic & Market Assessment
San Diego Commercial SQ.FT. > 10,000,1990	38,516,722	Chula Vista Socioeconomic & Market Assessment
Chula Vista Commercial SQ.FT. > 10,000,1990	518,812	Chula Vista Socioeconomic & Market Assessment
CV Calculated Residential KWh/Year, 1990:	232,750,706	Sandag Fax June 16
CV Calculated Commercial KWh/Year, 1990:	104,960,298	Criterion Estimate
CV Calculated Transp, KWh/Year, 1990:	50,252	Criterion Estimate
CV Calculated Industrial, KWh/Year, 1990:	178,690,426	Criterion Estimate
CV Total KWh/Year, 1990:	516,451,682	Criterion Estimate
Natural Gas Power Plant Overall Efficiency	30.00%	Criterion Estimate
Biomass Power Plant Overall Efficiency	30.00%	Criterion Estimate
Fuel Oil Power Plant Overall Efficiency	27.00%	Criterion Estimate
Coal Power Plant Overall Efficiency	27.00%	Criterion Estimate

EMISSION DATA SOURCES AND ASSUMPTIONS *Continued*

Parameter	Value	Source
San Diego Electric Generation, GWH, 1990, with Natural Gas	5,098	CEC, ER-92
San Diego Electric Generation, GWH, 1990, with Nuclear	3,222	CEC, ER-92
San Diego Electric Generation, GWH, 1990, with Biomass	31	CEC, ER-92
San Diego Electric Generation, GWH, 1990, with Hydro	1,064	CEC, ER-92
San Diego Electric Generation, GWH, 1990, with Fuel Oil	534	CEC, ER-92
San Diego Electric Generation, GWH, 1990, with Coal	2,749	CEC, ER-92
San Diego Electric Generation, GWH, 1990, with Geothermal	1,134	CEC, ER-92
Actual Natural Gas Btu/FT ³ =V * PF * TF * CR * Energy/Unit	13,833	Natural Gas Industry Estimates
V (FT ³)	1.00	
PF (Pressure Factor)	1.00	Criterion Estimate
TF (Temperature Factor)	1.03	Criterion Estimate
CR (Correction Factor)	1.002	Criterion Estimate
Energy input (950 - 1050)	1,020	Natural Gas Industry Estimates
Natural Gas Volume Unaccounted for	0.50%	Natural Gas Industry Estimates
Therms/Year/Dwelling, San Diego, 1990:	341	San Diego REP Demand & Supply Database
Therms/Year/SF, San Diego, 1990:	0.32	San Diego REP Demand & Supply Database
Therms/Year/Employee, San Diego, 1990:	232	San Diego REP Demand & Supply Database
CV Calculated Residential Therm/Year, 1990:	16,408,712	SDGE Fax June 16, 1994
CV Calculated Commercial Therm/Year, 1990:	4,065,294	SDGE Fax June 16, 1994
CV Calculated Industrial, Therm/Year, 1990:	7,298,518	SDGE Fax June 16, 1994
CV Calculated Transportation, Therm/Year, 1990:	115	Criterion Estimate
CV Total Therm/Year, 1990:	27,772,639	Criterion Estimate
Chula Vista VMT, 1990:	1,041,083,750	Telephone conversation with Meghan Scott on 7/26/94
San Diego VMT, 1990:	22,849,927,100	Fax from SANDAG 5/5/94
San Diego Gasoline MMBtu, 1990:	125,847,556	San Diego REP Demand & Supply Database
San Diego Diesel MMBtu, 1990:	12,158,777	San Diego REP Demand & Supply Database
San Diego LPG MMBtu, 1990:	553,281	San Diego REP Demand & Supply Database
Chula Vista Electric MMBtu (Rail), 1990:	1,486	Green Fleet Survey Estimate
Calculated CV Gasoline Consumption, MMBtu, 1990:	5,733,841	Criterion Estimate
Calculated CV Diesel Consumption, MMBtu, 1990:	553,976	Criterion Estimate
Calculated CV LPG Consumption, MMBtu, 1990:	25,208	Criterion Estimate
CV Bus Fuel Consumption, Diesel, MMBtu 1992:	32,536	Green Fleet Survey Estimate
CV Rail Fuel Consumption, Electric, MMBtu 1992:	1,486	Green Fleet Survey Estimate
CVP Compact Car Fuel Consumption, Gasoline, MMBtu 1992:	1,627	Green Fleet Survey Estimate
CVP Full-Size Car Fuel Consumption, Gasoline, MMBtu 1992:	553	Green Fleet Survey Estimate
CVP Light Van/Truck Fuel Consumption, Gasoline, MMBtu 1992:	2,786	Green Fleet Survey Estimate
CVP Light Van/Truck Consumption, CNG, MMBtu 1992:	100	Green Fleet Survey Estimate
CVP Heavy Truck Fuel Consumption, Gasoline, MMBtu 1992:	279	Green Fleet Survey Estimate
CVP Heavy Truck Consumption, Diesel, MMBtu 1992:	2,180	Green Fleet Survey Estimate
CVP Police Car Fuel Consumption, Gasoline, MMBtu 1992:	12,025	Green Fleet Survey Estimate
CVP Fire Truck Consumption, Diesel, MMBtu 1992:	4,100	Green Fleet Survey Estimate
CVP Heavy Equip. Consumption, Diesel, MMBtu 1992:	1,093	Green Fleet Survey Estimate
CVP Full-Size Pick-Up Fuel Consumption, Gasoline, MMBtu 1992:	5,997	Green Fleet Survey Estimate
CVP Full-Size Pick-Up Con., Diesel, MMBtu 1992:	599	Green Fleet Survey Estimate
Police/Fire/Regulation, Electric Consumption, KWh	1,982,922	SDGE9293 Expense Allocation Recap
Street Lighting, Electric Consumption, KWh	42,935,994	SDGE9293 Expense Allocation Recap
Public Works/Sp. Interest/Recreation, Electric Consumption, KWh	2,946,498	SDGE9293 Expense Allocation Recap
Water & Wastewater, Electric Consumption, KWh	2,078,721	SDGE9293 Expense Allocation Recap
Building Maintenance, Electric Consumption, KWh	1,042,218	SDGE9293 Expense Allocation Recap

EMISSION DATA SOURCES AND ASSUMPTIONS *Continued*

Parameter	Value	Source
Parks/Open Spaces, Electric Consumption, KWh	375,031	SDGE9293 Expense Allocation Recap
Police/Fire/Regulation, NG Consumption, Therms	32,778	SDGE9293 Expense Allocation Recap
Public Works/Sp. Interest/Recreation, NG Consumption, Therms	102,803	SDGE9293 Expense Allocation Recap
Building Maintenance, NG Consumption, Therms	2,251	SDGE9293 Expense Allocation Recap
San Diego Auto Gasoline Consumption, MMBtu, 1990	81,340,596	San Diego REP Demand & Supply Database
San Diego Auto Diesel Consumption, MMBtu, 1990	1,430,402	San Diego REP Demand & Supply Database
San Diego Truck<10000 Gasoline Consumption, MMBtu, 1990	42,438,668	San Diego REP Demand & Supply Database
San Diego Truck<10000 Diesel Consumption, MMBtu, 1990	584,724	San Diego REP Demand & Supply Database
San Diego Truck<19000 Gasoline Consumption, MMBtu, 1990	667,269	San Diego REP Demand & Supply Database
San Diego Truck<19000 Diesel Consumption, MMBtu, 1990	30,809	San Diego REP Demand & Supply Database
San Diego Truck<26000 Gasoline Consumption, MMBtu, 1990	812,437	San Diego REP Demand & Supply Database
San Diego Truck<26000 Diesel Consumption, MMBtu, 1990	985,637	San Diego REP Demand & Supply Database
San Diego Truck<33000 Gasoline Consumption, MMBtu, 1990	178,792	San Diego REP Demand & Supply Database
San Diego Truck<33000 Diesel Consumption, MMBtu, 1990	292,008	San Diego REP Demand & Supply Database
San Diego Truck<33000 LPG Consumption, MMBtu, 1990	553,281	San Diego REP Demand & Supply Database
San Diego Truck>33000 Gasoline Consumption, MMBtu, 1990	137,981	San Diego REP Demand & Supply Database
San Diego Truck>33000 Diesel Consumption, MMBtu, 1990	8,006,462	San Diego REP Demand & Supply Database
San Diego Motorcycle Gasoline Consumption, MMBtu, 1990	271,812	San Diego REP Demand & Supply Database
Calc. CV Auto Gasoline Consumption, MMBtu, 1990	3,706,024	Criterion Estimate
Calc. CV Auto Diesel Consumption, MMBtu, 1990	65,172	Criterion Estimate
Calc. CV Truck<10000 Gasoline Consumption, MMBtu, 1990	1,933,582	Criterion Estimate
Calc. CV Truck<10000 Diesel Consumption, MMBtu, 1990	26,641	Criterion Estimate
Calc. CV Truck<19000 Gasoline Consumption, MMBtu, 1990	30,402	Criterion Estimate
Calc. CV Truck<19000 Diesel Consumption, MMBtu, 1990	1,404	Criterion Estimate
Calc. CV Truck<26000 Gasoline Consumption, MMBtu, 1990	37,016	Criterion Estimate
Calc. CV Truck<26000 Diesel Consumption, MMBtu, 1990	44,907	Criterion Estimate
Calc. CV Truck<33000 Gasoline Consumption, MMBtu, 1990	8,146	Criterion Estimate
Calc. CV Truck<33000 Diesel Consumption, MMBtu, 1990	13,304	Criterion Estimate
Calc. CV Truck<33000 LPG Consumption, MMBtu, 1990	25,208	Criterion Estimate
Calc. CV Truck>33000 Gasoline Consumption, MMBtu, 1990	6,287	Criterion Estimate
Calc. CV Truck>33000 Diesel Consumption, MMBtu, 1990	364,789	Criterion Estimate
Calc. CV Motorcycle Gasoline Consumption, MMBtu, 1990	12,384	Criterion Estimate
San Diego Res Electric Space Heating, KWh, 1990	221,000,000	San Diego REP Demand & Supply Database
San Diego Res Electric Space Cooling, KWh, 1990	104,000,000	San Diego REP Demand & Supply Database
San Diego Res Electric DHW, KWh, 1990	212,000,000	San Diego REP Demand & Supply Database
San Diego Res Electric Appliances, KWh, 1990	2,627,000,000	San Diego REP Demand & Supply Database
San Diego Res Electric Lighting/Pool, KWh, 1990	1,932,000,000	San Diego REP Demand & Supply Database
San Diego Res Natural Gas Space Heating, Therms, 1990	92,000,000	San Diego REP Demand & Supply Database
San Diego Res Natural Gas DHW, Therms, 1990	108,000,000	San Diego REP Demand & Supply Database
San Diego Res Natural Gas Appliances, Therms, 1990	9,000,000	San Diego REP Demand & Supply Database
San Diego Res Natural Gas Spa/Pool, Therms, 1990	116,000,000	San Diego REP Demand & Supply Database
Calculated Res CV Electric Space Heating, KWh, 1990	10,093,781	Criterion Estimate
Calculated Res CV Electric Space Cooling, KWh, 1990	4,750,014	Criterion Estimate
Calculated Res CV Electric DHW, KWh, 1990	9,682,722	Criterion Estimate
Calculated Res CV Electric Appliances, KWh, 1990	119,983,537	Criterion Estimate
Calculated Res CV Electric Lighting/Pool, KWh, 1990	88,240,652	Criterion Estimate
Calculated Res CV Natural Gas Space Heating, Therms, 1990	4,644,928	Criterion Estimate
Calculated Res CV Natural Gas DHW, Therms, 1990	5,452,741	Criterion Estimate
Calculated Res CV Natural Gas Appliances, Therms, 1990	454,395	Criterion Estimate

EMISSION DATA SOURCES AND ASSUMPTIONS *Continued*

Parameter	Value	Source
Calculated Res CV Natural Gas Spa/Pool, Therms, 1990	5,856,648	Criterion Estimate
San Diego Com Electric Space Heating, KWh, 1990	82,000,000	San Diego REP Demand & Supply Database
San Diego Com Electric Space Cooling, KWh, 1990	1,561,000,000	San Diego REP Demand & Supply Database
San Diego Com Electric DHW, KWh, 1990	52,000,000	San Diego REP Demand & Supply Database
San Diego Com Electric Ventilation, KWh, 1990	577,000,000	San Diego REP Demand & Supply Database
San Diego Com Electric Lighting, KWh, 1990	1,997,000,000	San Diego REP Demand & Supply Database
San Diego Com Electric Equipment, KWh, 1990	2,492,000,000	San Diego REP Demand & Supply Database
San Diego Com Natural Gas Space Heating, Therms, 1990	42,860,000	San Diego REP Demand & Supply Database
San Diego Com Natural Gas Space Cooling, Therms, 1990	14,670,000	San Diego REP Demand & Supply Database
San Diego Com Natural Gas DHW, Therms, 1990	18,540,000	San Diego REP Demand & Supply Database
San Diego Com Natural Gas Cooking, Therms, 1990	40,000,000	San Diego REP Demand & Supply Database
San Diego Com Natural Gas Misc., Therms, 1990	13,330,000	San Diego REP Demand & Supply Database
Calculated CV Com Electric Space Heating, KWh, 1990	1,272,999	Criterion Estimate
Calculated CV Com Electric Space Cooling, KWh, 1990	24,233,549	Criterion Estimate
Calculated CV Com Electric DHW, KWh, 1990	807,267	Criterion Estimate
Calculated CV Com Electric Ventilation, KWh, 1990	8,957,564	Criterion Estimate
Calculated CV Com Electric Lighting, KWh, 1990	31,002,176	Criterion Estimate
Calculated CV Com Electric Equipment, KWh, 1990	38,686,742	Criterion Estimate
Calculated CV Com Natural Gas Space Heating, Therms, 1990	1,346,511	Criterion Estimate
Calculated CV Com Natural Gas Space Cooling, Therms, 1990	460,880	Criterion Estimate
Calculated CV Com Natural Gas DHW, Therms, 1990	582,462	Criterion Estimate
Calculated CV Com Natural Gas Cooking, Therms, 1990	1,256,660	Criterion Estimate
Calculated CV Com Natural Gas Misc., Therms, 1990	418,782	Criterion Estimate
San Diego Industrial Electric, KWh, 1990	1,971,000,000	San Diego REP Demand & Supply Database
San Diego Industrial Natural Gas, Therms, 1990	48,600,000	San Diego REP Demand & Supply Database
Calculated CV Agric./Forest./Mining Electric, KWh, 1990	8,642,211	Criterion Estimate
Calculated CV Construction Electric, KWh, 1990	51,973,670	Criterion Estimate
Calculated CV Manufacturing (non-durable) Electric, KWh, 1990	23,036,978	Criterion Estimate
Calculated CV Manufacturing (durable) Electric, KWh, 1990	95,104,458	Criterion Estimate
Calculated CV Agric./Forest./Mining Natural Gas, Therms, 1990	352,987	Criterion Estimate
Calculated CV Construction Natural Gas, Therms, 1990	2,122,838	Criterion Estimate
Calculated CV Manufacturing (non-durable) Natural Gas, Therms, 1990	940,933	Criterion Estimate
Calculated CV Manufacturing (durable) Natural Gas, Therms, 1990	3,884,492	Criterion Estimate
CV Jan 93 kWhr, w/City, Federal exempt	49,894,540	City of Chula Vista, Finance Department
CV Feb 93 kWhr, w/City, Federal exempt	41,756,942	City of Chula Vista, Finance Department
CV Mar 93 kWhr, w/City, Federal exempt	41,732,474	City of Chula Vista, Finance Department
CV Apr 93 kWhr, w/City, Federal exempt	39,904,882	City of Chula Vista, Finance Department
CV May 93 kWhr, w/City, Federal exempt	38,696,474	City of Chula Vista, Finance Department
CV Jun 93 kWhr, w/City, Federal exempt	40,930,401	City of Chula Vista, Finance Department
CV Jul 93 kWhr, w/City, Federal exempt	44,955,442	City of Chula Vista, Finance Department
CV Aug 93 kWhr, w/City, Federal exempt	41,600,291	City of Chula Vista, Finance Department
CV Sep 93 kWhr, w/City, Federal exempt	44,679,165	City of Chula Vista, Finance Department
CV Oct 93 kWhr, w/City, Federal exempt	43,095,405	City of Chula Vista, Finance Department
CV Nov 93 kWhr, w/City, Federal exempt	40,209,484	City of Chula Vista, Finance Department
CV Dec 93 kWhr, w/City, Federal exempt	42,987,826	City of Chula Vista, Finance Department
CV Total 93 kWhr, w/City, Federal exempt	510,443,326	City of Chula Vista, Finance Department
CV Jan 93 Therm, w/City, Federal exempt	3,987,375	City of Chula Vista, Finance Department
CV Feb 93 Therm, w/City, Federal exempt	3,470,862	City of Chula Vista, Finance Department
CV Mar 93 Therm, w/City, Federal exempt	2,856,111	City of Chula Vista, Finance Department

EMISSION DATA SOURCES AND ASSUMPTIONS *Continued*

Parameter	Value	Source
CV Apr 93 Therm, w/City, Federal exempt	1,926,930	City of Chula Vista, Finance Department
CV May 93 Therm, w/City, Federal exempt	1,541,427	City of Chula Vista, Finance Department
CV Jun 93 Therm, w/City, Federal exempt	2,457,267	City of Chula Vista, Finance Department
CV Jul 93 Therm, w/City, Federal exempt	1,997,338	City of Chula Vista, Finance Department
CV Aug 93 Therm, w/City, Federal exempt	2,025,592	City of Chula Vista, Finance Department
CV Sep 93 Therm, w/City, Federal exempt	2,045,625	City of Chula Vista, Finance Department
CV Oct 93 Therm, w/City, Federal exempt	1,970,562	City of Chula Vista, Finance Department
CV Nov 93 Therm, w/City, Federal exempt	2,113,377	City of Chula Vista, Finance Department
CV Dec 93 Therm, w/City, Federal exempt	3,032,694	City of Chula Vista, Finance Department
CV Total 93 Therm, w/City, Federal exempt	29,425,160	City of Chula Vista, Finance Department
Chula Vista 1993 Persons	146,197	Chula Vista Socioeconomic & Market Assessment
CV Total 90 KWhr, w/City, Federal exempt	471,824,109	Criterion Estimate
CV Total 90 Therms, w/City, Federal exempt	27,198,906	Criterion Estimate
Chula Vista 2010 VMT	1,505,562,450	Telephone conversation with Meghan Scott on 7/26/94

Appendix B
1990 EMISSIONS INVENTORY

Energy Consumption

Emissions are directly created by energy consumption when fuel is combusted by end-users, such as motorists using gasoline and homes and businesses using natural gas. Emissions are indirectly created by electrical end-use, i.e., using electricity in a home requires generation at a power plant that, in turn, emits CO₂. Inventorying and evaluating the ways in which Chula Vistans consume energy forms the basis for subsequent policy and action measures for using energy more efficiently and thereby reducing CO₂ emissions.

Chula Vista's energy consumption is organized into five end-use sectors: municipal government, transportation, residential, commercial, and industrial. Energy use in each of these sectors has been inventoried by fuel type, which is the basis for CO₂ emission estimates. Based on CEC and EPA estimates of the amount of carbon in various fuels, emission coefficients have been developed and applied to each type of energy unit as follows:

	CO ₂	
	<u>Lbs</u>	<u>Lbs/MMBtu</u>
One gallon of gasoline	19.37	152
One gallon of diesel	23.58	169
One therm of natural gas	12.58	116
One kilowatt-hour (kwh) of electricity (based on SDG&E's 1990 resource mix)	1.24	364

Municipal Government

Chula Vista's municipal government uses energy in three ways: fueling municipal-owned vehicles; space conditioning and powering municipal-owned buildings; and powering certain public services, such as street lighting and park irrigation. Although municipal government energy consumption is the smallest of the end-use sectors, it nonetheless is most directly subject to public policy, and can therefore be used to set a leadership example for other sectors. Additionally, using municipal energy more efficiently not only reduced CO₂ emissions, but also saves monies that can be redirected to other critical public service needs.

Table 1 estimates CO₂ emissions associated with municipal vehicles, including the City's pro rata share of regional transit service (bus and rail); and Table 2 tabulates CO₂ emissions attributable to municipal buildings and services. These data are also summarized in Figures 1 and 2.

Table 1
Municipal Government Vehicles

Vehicle Type	Fuel Type	Quantity		CO ₂ Emissions		
		MMBtu	%	Tons	%	Lbs per Capita
Compact Car	Gasoline	1,627	2	146	2	2
Full-Size Car	Gasoline	553	1	50	1	1
Light Van/Truck	Gasoline	2,786	4	251	4	4
Light Van/Truck	CNG	100	0	7	0	0
Heavy Truck	Gasoline	279	0	25	0	0
Heavy Truck	Diesel	2,180	3	212	3	3
Police Car	Gasoline	12,025	18	1,082	17	16
Fire Truck	Diesel	4,100	6	398	6	6
Heavy Equipment	Diesel	1,093	2	106	2	2
Full-Size Pick-Up	Gasoline	5,997	9	540	9	8
Full-Size Pick-Up	Diesel	599	1	58	1	1
Bus	Diesel	32,536	51	3,161	50	47
Rail	Electric	1,486	3	270	5	4
Total		65,361	100	6,306	100	94

Source: City of Chula Vista.

Table 2
Municipal Buildings and Services

Building Type	Electricity MMBtu	Natural Gas MMBtu	Total Energy Consumed		CO ₂ Emissions		
			MMBtu	%	Tons	%	Lbs per Capita
Police/Fire	6,768	3,278	10,046	5	1,438	4	21
Street Lighting	146,541	0	146,541	78	26,668	81	395
Public Works/Recreation	10,056	10,280	20,337	11	2,477	8	37
Water and Wastewater	7,095	0	7,095	4	1,291	4	19
General Building Operations	3,557	225	3,782	2	661	2	10
Parks Lighting/Irrigation	1,280	0	1,280	0	233	1	3
Total	175,297	13,783	189,081	100	32,768	100	485

Source: City of Chula Vista and SDG&E.

Figure 1

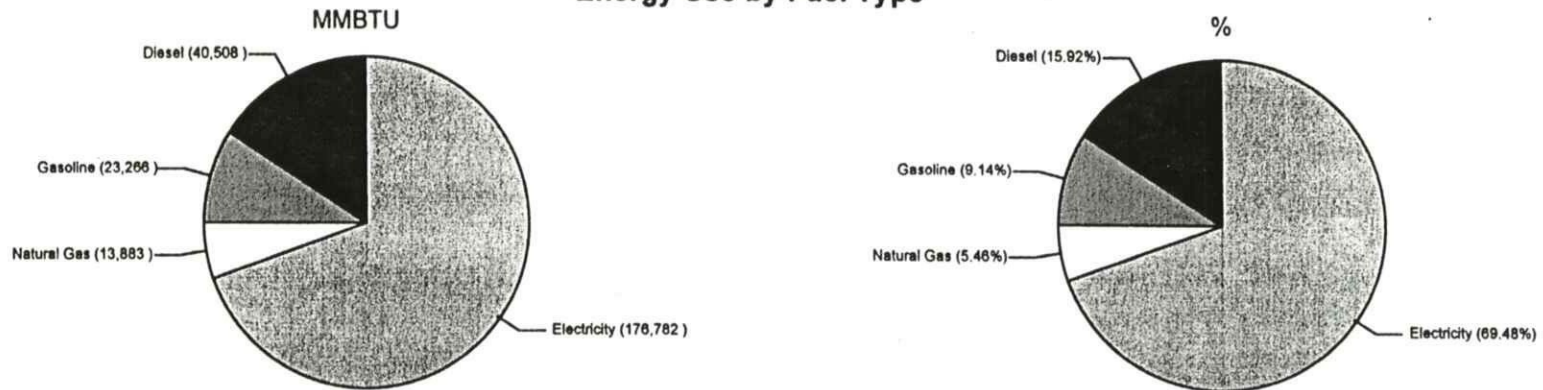
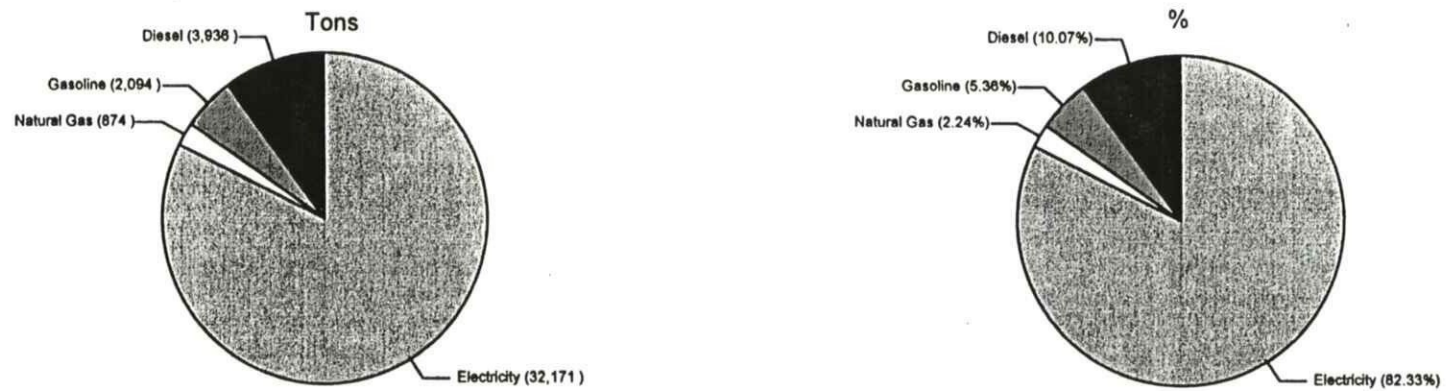
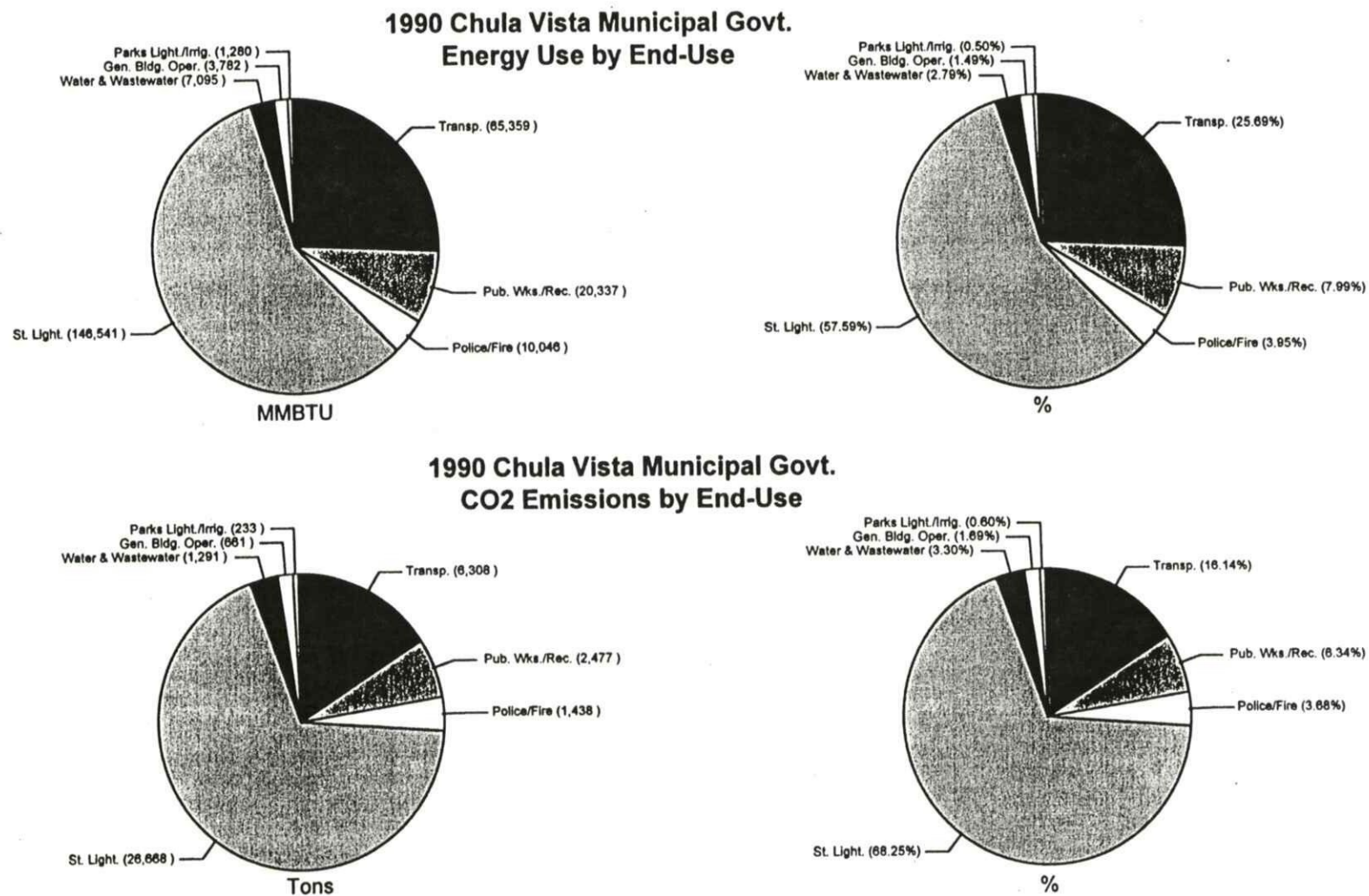
**1990 Chula Vista Municipal Govt.
Energy Use by Fuel Type****1990 Chula Vista Municipal Govt.
CO2 Emissions by Fuel Type**

Figure 2



Transportation

Chula Vista's largest energy end-use sector is transportation, which reflects the community's dependence on automobiles for a large majority of its travel needs. Chula Vistans use their automobiles and trucks to travel over one billion miles annually, emitting nearly 600,000 tons of CO₂ in the process. This represents slightly over 50% of the community's annual CO₂ emissions.

Tables 3 through 5 summarize these emissions by vehicle and fuel type, and trip destination, respectively. Figure 3 depicts fuel shares and their CO₂ emissions. These data include the municipally-owned vehicles that were inventoried in Section 1.1.

The trip destination information in Table 5 is noteworthy because of the significant amount of CO₂ emissions created by Chula Vistans traveling outside the community for employment and other purposes elsewhere in the region; along with vehicles trips originating elsewhere and ending in Chula Vista, e.g., workers commuting to Chula Vista job sites. Thus, Chula Vista's transportation emissions are closely related with the larger, but similarly auto-dependent, San Diego regional transportation system and its capabilities to offer low emission alternatives such as transit.

Table 3
Transportation Energy Consumption by Vehicle Type

Vehicle Type	Fuel Type	Quantity		CO ₂ Emissions (Tons)		
		MMBtu	%	Total	%	Lbs per Capita
Auto	Gasoline	3,706,024	59	333,624	58	4,938
	Diesel	65,172	1	6,332	1	94
Truck < 10,000 lbs	Gasoline	1,933,582	31	174,065	30	2,576
	Diesel	26,641	0	2,588	1	38
	CNG	100	0	7	0	0
Truck 10,000-19,000 lbs	Gasoline	30,402	1	2,737	1	41
	Diesel	1,404	0	136	0	2
Truck 19,001-26,000 lbs	Gasoline	37,016	1	3,332	1	49
	Diesel	44,907	1	4,363	1	65
Truck 26,001-33,000 lbs	Gasoline	8,146	0	733	0	11
	Diesel	13,304	0	1,293	0	19
	Propane	25,208	0	2,181	1	32
Truck > 33,000 lbs	Gasoline	6,565	0	591	0	9
	Diesel	372,162	6	36,160	6	535
Motorcycle	Gasoline	12,384	0	1,115	0	16
Rail	Electric	1,486	0	270	0	4
Total		6,284,503	100	569,527	100	8,429

Source: SANDAG, City of Chula Vista, and Criterion.

Figure 3

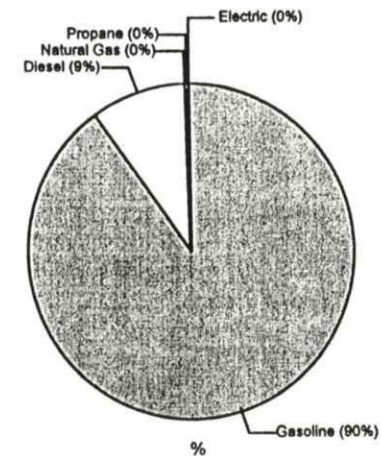
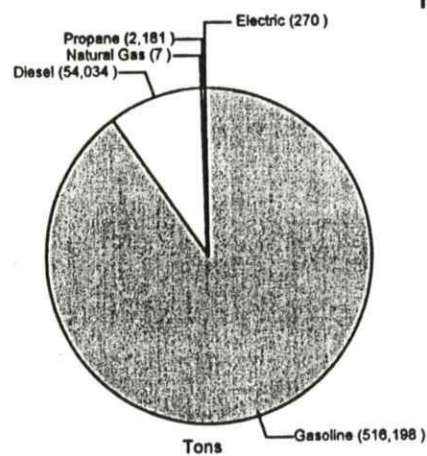
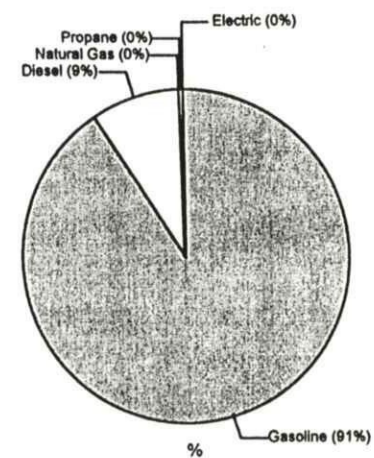
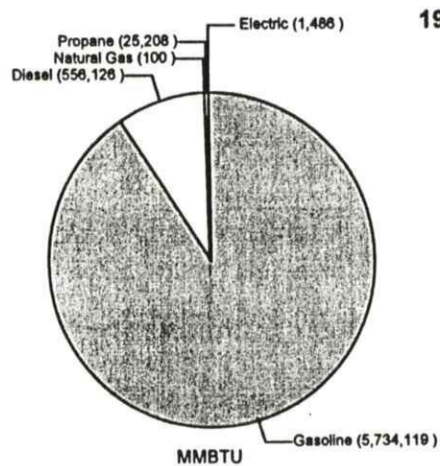


Table 4
Transportation Energy Consumption by Fuel Type

Fuel Type	Quantity		CO ₂ Emissions (Tons)		
	MMBtu	%	Total	%	Lbs per Capita
Gasoline	5,734,119	91	516,198	90	7,640
Diesel	556,126	9	54,034	9	800
Natural Gas	100	0	7	0	0
Propane	25,208	0	2,181	1	32
Electric	1,486	0	270	0	4
Total	6,317,039	100	572,690	100	8,476

Source: SANDAG, City of Chula Vista, and Criterion

Table 5
Transportation Energy Consumption by Trip Destination

Vehicle Destination	Quantity		CO ₂ Emissions (Tons)		
	MMBtu	%	Total	%	Lbs per Capita
Beginning in Chula Vista Ending in Chula Vista	1,642,430	26	148,899	26	1
Beginning in Chula Vista Ending Elsewhere	2,589,986	41	234,803	41	2
Beginning Elsewhere Ending in Chula Vista	2,084,623	33	188,988	33	1
Total	6,317,039	100	572,690	100	4

Source: SANDAG, City of Chula Vista, and Criterion

Residential

After transportation, the second largest energy user is Chula Vista's residential sector. This sector included 49,849 dwelling units in 1990, 46% of which were detached single-family homes, and 24% of which were apartment buildings with ten or more units. Chula Vista's residences are relatively young; 23% were built since 1980, and another 60% between 1950 and 1980. Table 6 estimates residential CO₂ emissions by end-use for both electricity and natural gas consumption in these dwellings, which are also summarized in Figures 4 and 5.

Figure 4

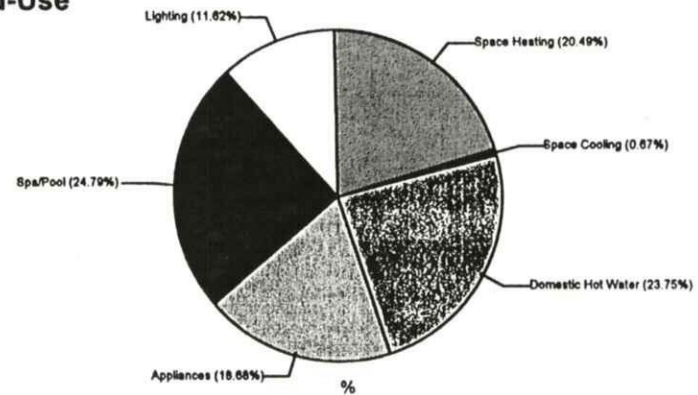
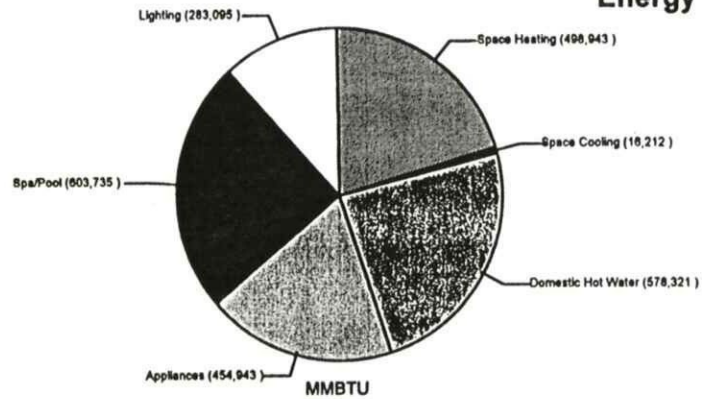
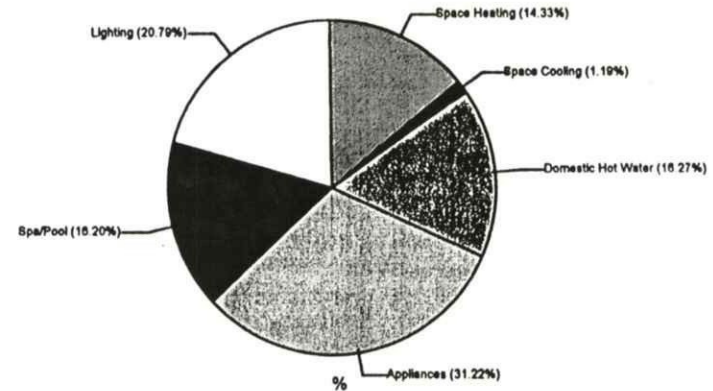
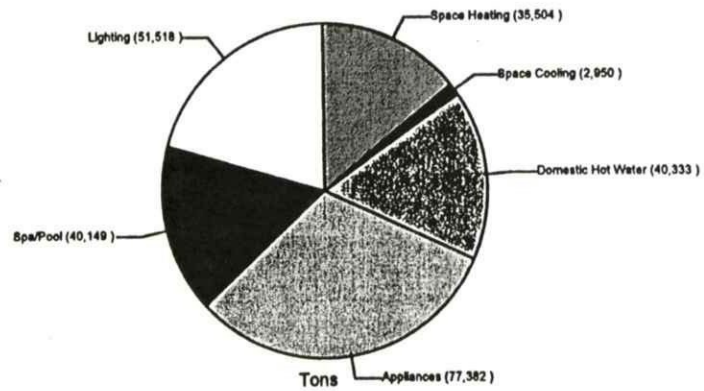
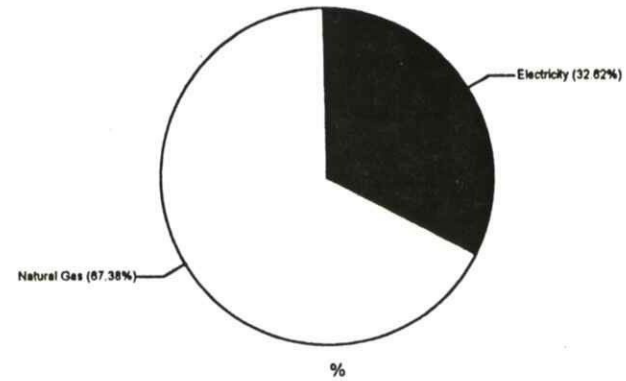
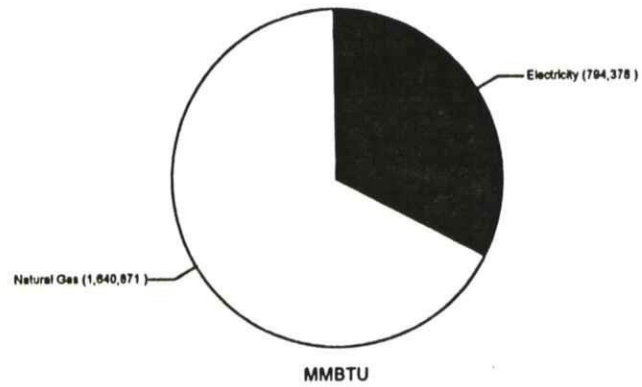
**1990 Chula Vista Residential
Energy Use by End-Use****1990 Chula Vista Residential
CO2 Emissions by End-Use**

Figure 5

**1990 Chula Vista Residential
Energy Use by Fuel Type**



**1990 Chula Vista Residential
CO2 Emissions by Fuel Type**

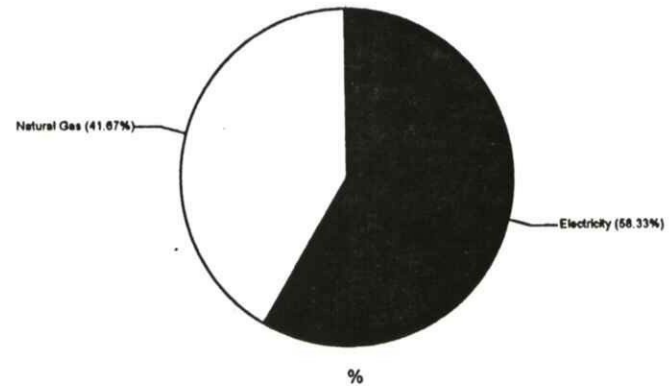
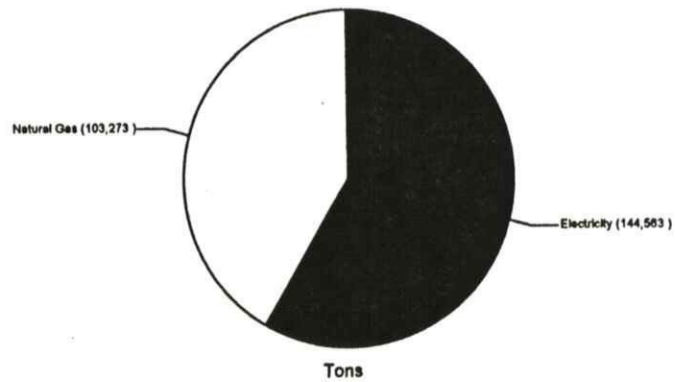


Table 6
Residential Energy Consumption By End-Use

End-Use	Electricity (MMBtu)	Natural Gas (MMBtu)	CO ₂ Emissions (Tons)			
			Product./ Distrib.	Consumption	Total	Lbs per Capita
Space Heating	34,450	0	6,269	0	6,269	93
Space Cooling	16,212	0	2,950	0	2,950	44
Domestic Hot Water	33,047	0	6,014	0	6,014	89
Appliances	409,504	0	74,522	0	74,522	1,103
Spa/Pool	18,070	0	3,288	0	3,288	49
Lighting	283,095	0	51,518	0	51,518	762
Total Electric	794,378	0	144,561	0	144,561	2,140
Space Heating	0	464,493	12	29,222	29,234	433
Domestic Hot Water	0	545,274	14	34,304	34,319	508
Appliances	0	45,440	1	2,859	2,860	42
Spa/Pool	0	585,665	16	36,845	36,861	546
Total Natural Gas	0	1,640,872	43	103,230	103,274	1,529
Grand Total	794,378	1,640,872	144,604	103,230	247,835	3,669

Source: SDG&E, City of Chula Vista, and Criterion

Commercial

The community's commercial sector is dominated by retail and service trades, whose CO₂ emissions are estimated in Table 7 by fuel type and end-use, and further summarized in Figures 6 and 7. It should be noted that SDG&E has only provided electric and natural gas end-use data that combine the commercial and industrial sectors, making it necessary to estimate the commercial share (SDG&E data also includes municipal usage). This estimate can be refined if and when actual sector data become available.

Table 7
Commercial Energy Consumption By End-Use

End-Use	Electricity (MMBtu)	Natural Gas (MMBtu)	CO ₂ Emissions (Tons)			
			Product./ Distrib.	Consumption	Total	Lbs per Capita
Space Heating	4,345	0	791	0	791	12
Space Cooling	82,709	0	15,052	0	15,052	223
Domestic Hot Water	2,755	0	501	0	501	7
Ventilation	30,572	0	5,564	0	5,564	82
Lighting	105,810	0	19,256	0	19,256	285
Equipment	132,038	0	24,029	0	24,029	356
Total Electric	358,229	0	65,193	0	65,193	965
Space Heating	0	134,651	4	8,471	8,475	125
Space Cooling	0	46,088	1	2,899	2,901	43
Domestic Hot Water	0	58,246	2	3,664	3,666	54
Cooking	0	125,666	3	7,906	7,909	117
Miscellaneous	0	41,878	1	2,635	2,636	39
Total Natural Gas	0	406,529	11	25,575	25,587	378
Grand Total	358,229	406,529	65,204	25,575	90,780	1,343

Source: SDG&E, City of Chula Vista, and Criterion

Figure 6

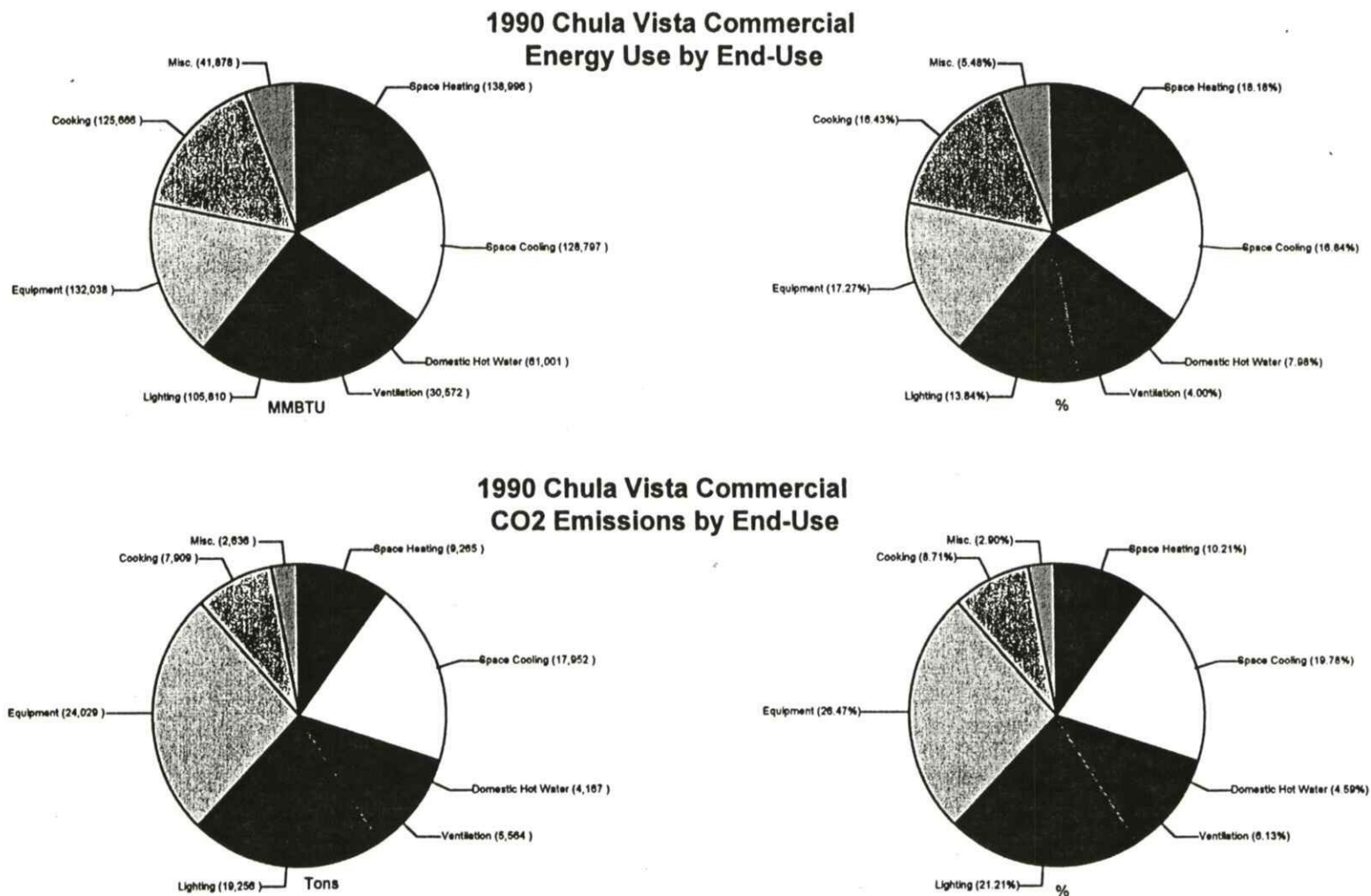
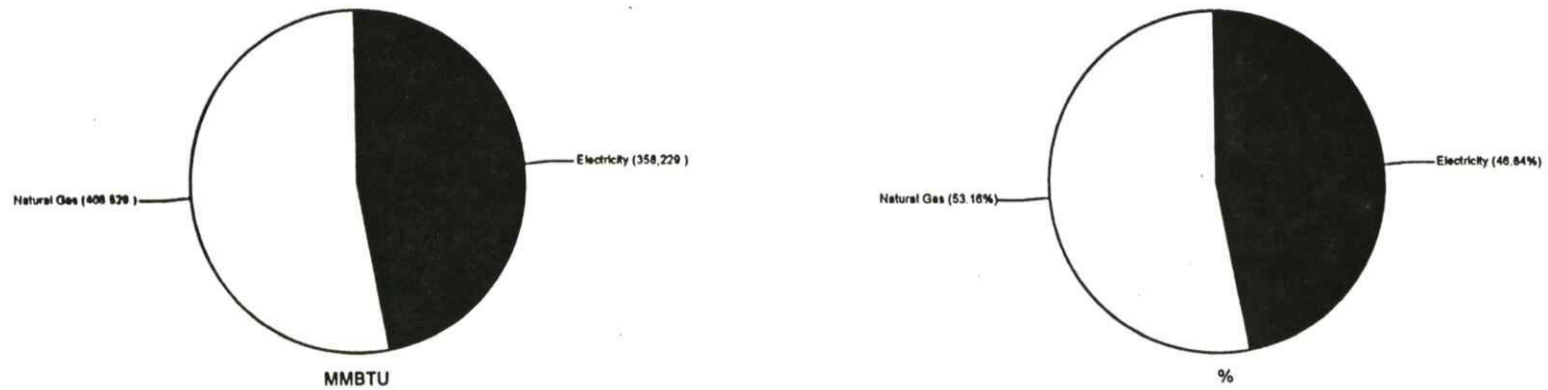
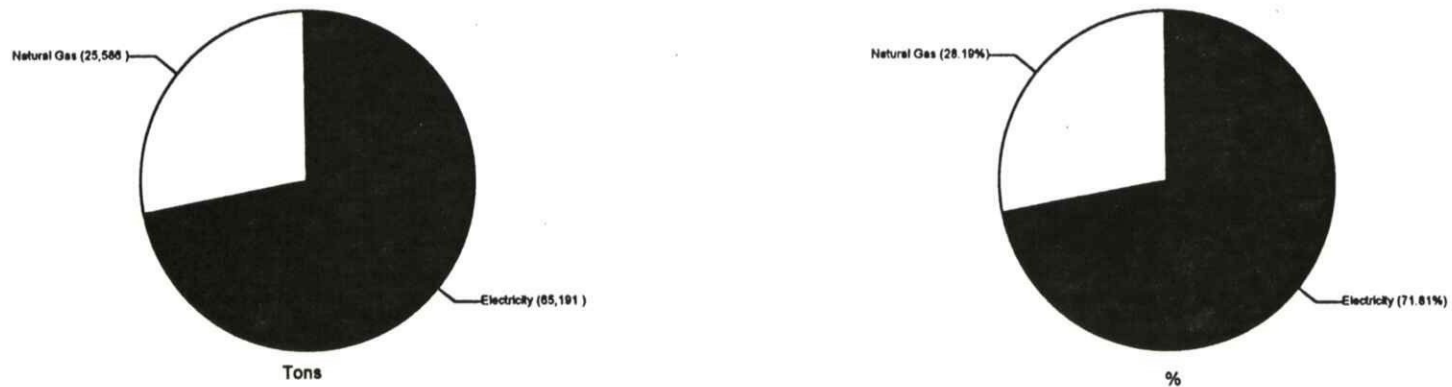


Figure 7

**1990 Chula Vista Commercial
Energy Use by Fuel Type**



**1990 Chula Vista Commercial
CO2 Emissions by Fuel Type**



Industrial

Chula Vista's industrial sector includes aerospace manufacturing and other light industries. Table 8 estimates CO₂ emissions for this sector by industry and fuel type, which are also summarized in Figures 8 and 9. It should be noted again that SDG&E has only provided electric and natural gas end-use data that combine the commercial and industrial sectors, making it necessary to estimate the industrial share. This estimate can be refined if and when actual industrial data are made available.

Table 8
Industrial Energy Consumption By Industry Sector

Sector	Electricity (MMBtu)	Natural Gas (MMBtu)	CO ₂ Emissions (Tons)			
			Product/ Distrib.	Consumption	Total	Lbs per Capita
Agriculture	29,496	0	5,368	0	5,368	79
Construction	177,386	0	32,281	0	32,281	478
Manufacturing (non-durable)	78,625	0	14,308	0	14,308	212
Manufacturing (durable)	324,592	0	59,070	0	59,070	874
Total Electric	610,099	0	111,027	0	111,027	1,643
Agriculture	0	35,299	1	2,221	2,222	33
Construction	0	212,284	6	13,355	13,362	198
Manufacturing (non-durable)	0	94,093	3	5,920	5,922	88
Manufacturing (durable)	0	388,449	12	24,438	24,450	362
Total Natural Gas	0	730,125	22	45,934	45,956	681
Grand Total	610,099	730,125	111,049	45,934	156,983	2,324

Source: SDG&E, City of Chula Vista, and Criterion

Energy Production and Distribution

The second portion of the 1990 inventory are those emissions created during energy production and distribution. For example, some electric power plants emit CO₂ when combusting fossil fuels to generate electricity; petroleum refineries emit CO₂ when distilling oil into transportation fuels; and large natural gas pipelines vent and burn off CO₂ and CH₄ during pipeline operations. These sources are organized by energy type, and further by their location either in Chula Vista or elsewhere but serving Chula Vista.

Electricity

Electricity is provided in Chula Vista solely by SDG&E (excepting for a small number of "self-generators," which are facilities that operate small power plants for their internal use). SDG&E generates electricity from power plants that it owns and operates throughout San Diego County, including the 700 MW South Bay plant in Chula Vista. It also purchases power from independent producers throughout the County, including several in Chula Vista, and from other utilities outside the region.

Figure 8

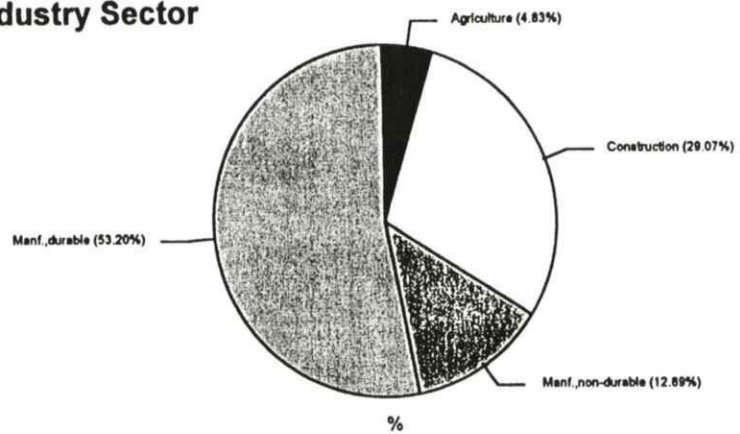
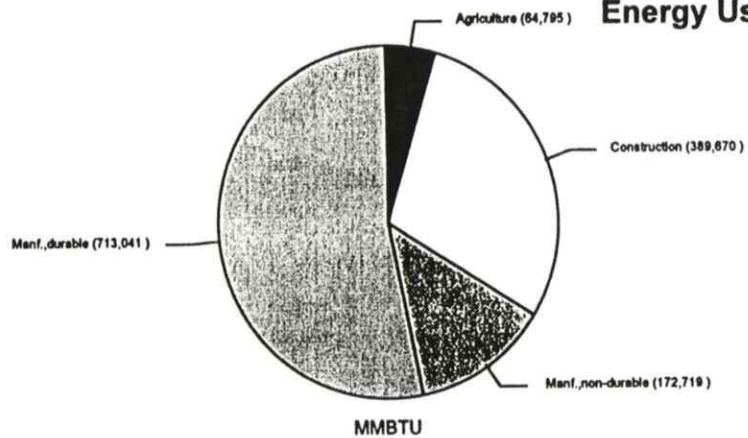
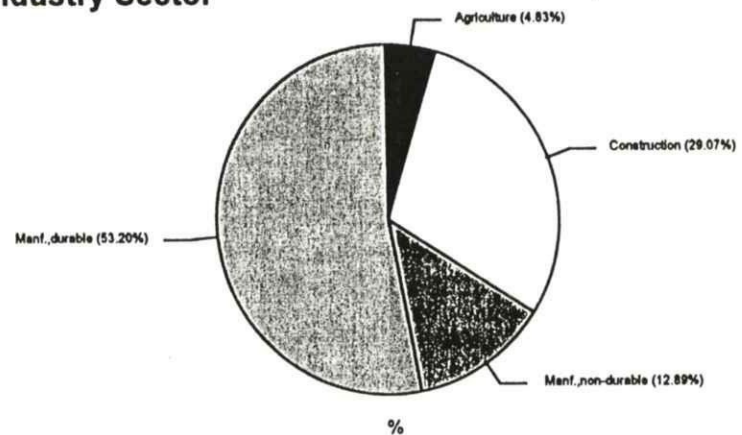
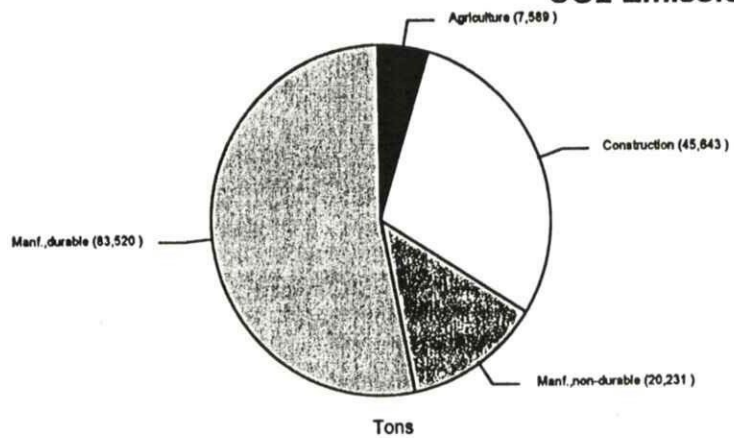
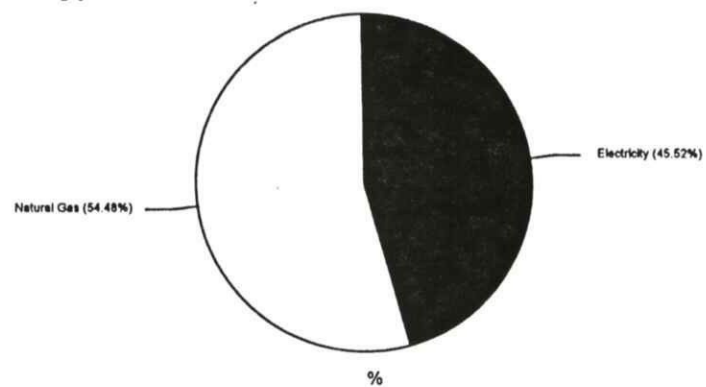
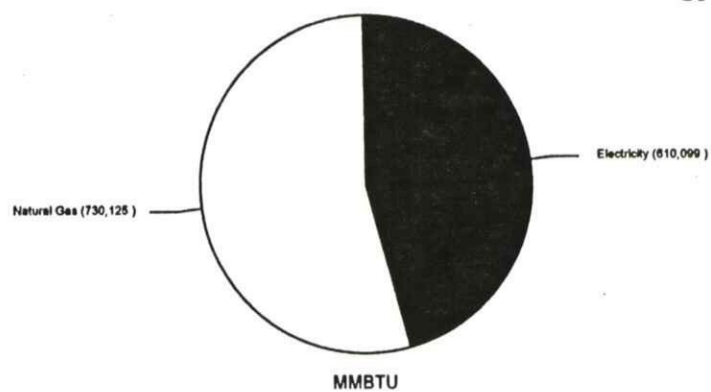
**1990 Chula Vista Industrial
Energy Use by Industry Sector****1990 Chula Vista Industrial
CO₂ Emissions by Industry Sector**

Figure 9

**1990 Chula Vista Industrial
Energy Use by Fuel Type**



**1990 Chula Vista Industrial
CO2 Emissions by Fuel Type**

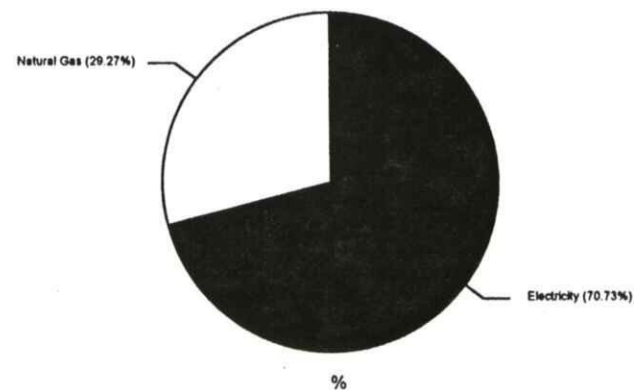
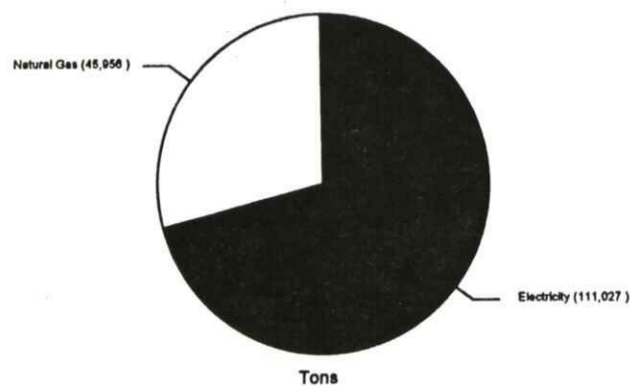


Table 9 lists the power plants located in Chula Vista, including both SDG&E and independent plants, and their estimated CO₂ emissions. As seen in these data, Chula Vista experiences power plant CO₂ emissions far in excess of its own electric end-use, with over 2½ million tons of CO₂ coming from SDG&E's South Bay plant alone every year. In contrast, the community's electric end-use creates only about 300,000 tons/year of CO₂ emissions (as inventoried in the previous section).

It is also worth noting in Table 9 that what is normally a community's largest source of methane emissions, the solid waste landfill, is being put to beneficial use in Chula Vista by methane recovery for fueling power generation.

Table 9
Power Plants in Chula Vista

Power Plant Name	Fuel Type	Size (MW)	CO ₂ Emissions (Tons)
Sharp Community Hospital	Natural gas	0.30	1,210
McDonalds	Natural gas	0.07	282
Otay 2 Landfill	Methane	1.88	7,585
Otay Landfill	Methane	1.88	7,585
Ramada Inn-Bonita	Natural gas	0.06	242
Royal Vista Inn	Natural gas	0.10	403
South Bay #1-4	Natural gas	690.00	2,783,861
South Bay Gt. #1	Natural gas	19.00	76,657
South Bay Regional Center	Natural gas	0.60	2,421
Total		713.89	2,880,246

Source: SDG&E and CEC.

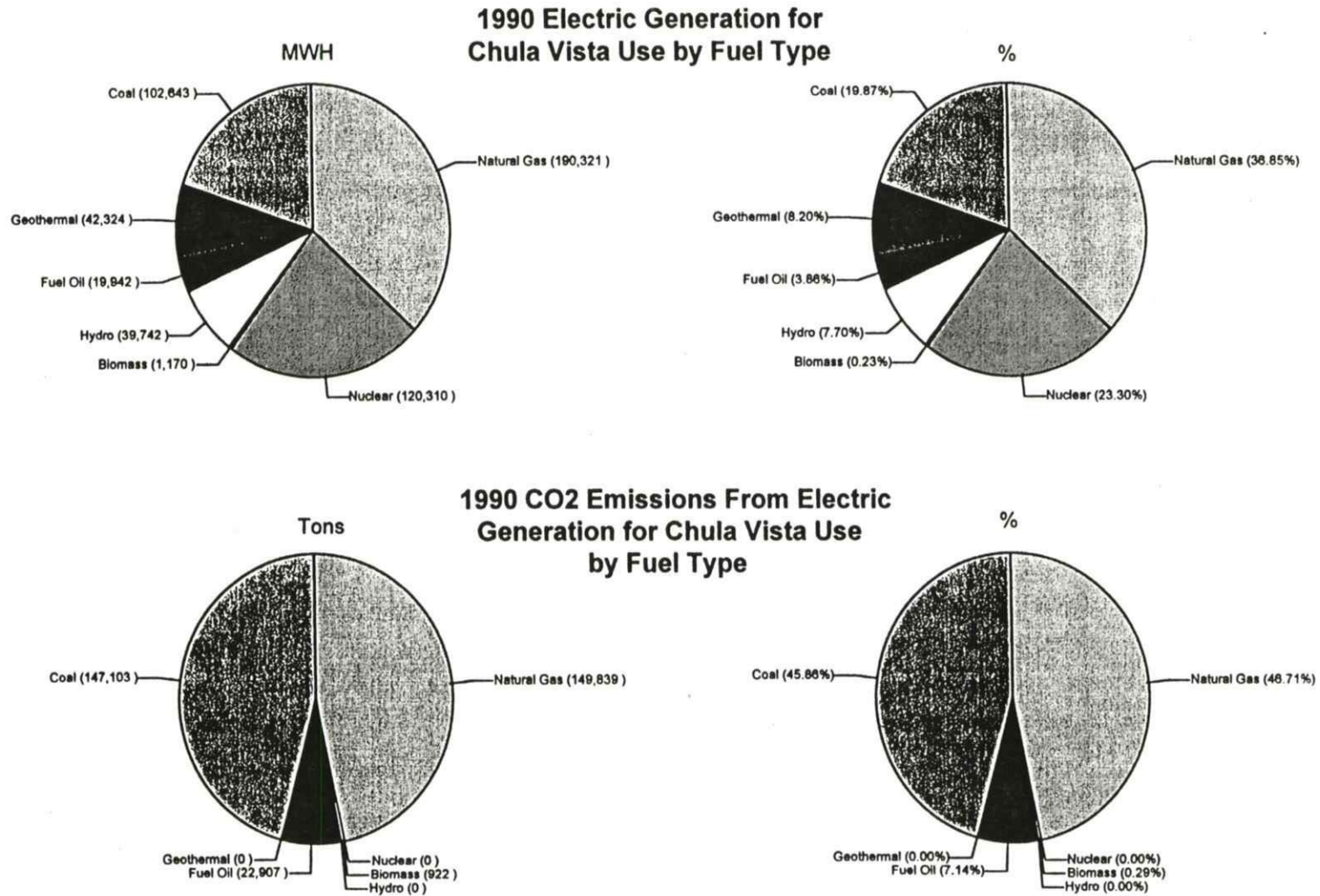
Table 10 and Figure 10 summarize Chula Vista's pro rata share of electric generation CO₂ emissions based on SDG&E's total resource mix in 1990. It is these 300,000 tons/year of emissions that reflect Chula Vista's actual electric use based on the carbon intensity of the mix of all fuels that SDG&E relies upon for power generation.

Table 10
Chula Vista Portion of Total SDG&E Resource Mix

Fuel Type	MWH		CO ₂ Emissions	
	Generated	%	Tons	%
Natural Gas	190,321	37	149,839	47
Nuclear	120,310	23	0	0
Biomass	1,170	0	922	0
Hydro	39,742	8	0	0
Fuel Oil	19,942	4	22,907	7
Geothermal	42,324	8	0	0
Coal	102,643	20	147,103	46
Total	516,452	100	320,771	100

Source: SDG&E and CEC.

Figure 10



Natural Gas

SDG&E also provides natural gas service in Chula Vista. There is no wellhead natural gas produced in San Diego County; all of SDG&E's supplies are purchased from out-of-region sources and piped into the County. Table 11 estimates CO₂ from pipeline flaring and methane venting associated with pipeline distribution, including deliveries to power plants and to residential and commercial direct-use consumers. Table 11 data are estimates that can be refined if actual SDG&E data becomes available.

Table 11
Pipeline Venting/Flaring from Natural Gas Delivered to Chula Vista

Chula Vista 1990	Quantity Supplied (Cubic Feet)	Venting/ Flaring (Cubic Feet)	CO ₂ Emissions (Tons)	CH ₄ Emissions (Tons of Equivalent CO ₂)
Direct Combustion	2,638,987,275	13,194,936	71	9,089
Power Plants	39,548,174,843	197,740,874	1,070	136,204
Total	42,187,162,118	210,935,810	1,141	145,293

Source: SDG&E and CEC.

Transportation Fuels

All petroleum-based transportation fuels used in Chula Vista are produced and refined outside of the region. Most gasoline and diesel supplies are refined at facilities in the Los Angeles area, and either piped or shipped by truck or rail into San Diego County. Table 12 estimates the pro rata share of CO₂ emissions from this refining and distribution attributable to Chula Vista's transportation demands.

Table 12
Petroleum Refining and Distribution

Petroleum Refining and Distribution	Quantity Supplied to Chula Vista		CO ₂ Emissions	
	MMBtu	%	Tons	%
Gasoline	5,757,106	90	81,492	91
Diesel	594,484	9	7,480	8
Propane	25,208	1	317	1
Total	6,376,798	100	89,289	100

Source: SANDAG and Criterion.

Emissions Summary

The 1990 inventory is summarized by end-use sector and fuel type in Tables 13 through 15, and Figures 11 and 12 (including production, distribution, and consumption-based emissions). The inventory describes a community where over 50% of the annual CO₂ emissions come from transportation energy use because of dependence on gasoline-fueled automobiles. The second largest contributor to emissions is electricity use in homes and businesses, which accounts for approximately one-quarter of the community's annual CO₂ emissions.

These Chula Vista conditions are compared to other ICLEI cities in Figures 13 through 16. When compared on the basis of transportation emissions, Chula Vista appears relatively favorably in comparison to other North American cities, but not so with European cities that are much less auto-dependent. In terms of electric-related emissions, Chula Vista's favorable position reflects the comparatively low carbon intensity of SDG&E's generation resource mix.

Table 13
Total Energy Consumption by End-Use Sector

End-Use Sector	Quantity		CO ₂ Emissions		
	MMBtu	%	Tons	%	Lbs per Capita
Residential	2,435,249	22	247,836	23	3,668
Commercial	575,679	5	58,009	5	859
Industrial	1,340,224	12	156,983	15	2,323
Municipal	254,438	2	39,076	4	578
Transportation	6,251,681	59	566,382	53	8,382
Total	10,857,271	100	1,068,286	100	15,810

Table 14
Total Energy Consumption by Fuel Type

Fuel Type	Quantity		CO ₂ Emissions		
	MMBtu	%	Tons	%	Lbs per Capita
Electricity	1,764,192	16	321,051	30	4,752
Natural Gas	2,777,625	26	174,823	16	2,587
Gasoline	5,757,385	53	516,198	48	7,640
Diesel	556,126	5	54,034	6	800
Propane	25,208	0	2,181	0	32
Total	10,880,536	100	1,068,287	100	15,811

Table 15
Total Energy Consumption by End-Use Sector and Fuel Type

End-Use Sector	Fuel Type	Quantity		CO ₂ Emissions		
		MMBtu	%	Tons	%	Lbs Per Capita
Residential	Electricity	794,378	33	144,563	58	2,140
	Natural Gas	1,640,871	67	103,273	42	1,528
	Gasoline	0.00	0.00	0.00	0.00	0.00
	Diesel	0.00	0.00	0.00	0.00	0.00
	Propane	0.00	0.00	0.00	0.00	0.00
Subtotal		2,435,249	100	247,836	100	3,668
Commercial	Electricity	182,933	32	33,291	57	493
	Natural Gas	392,746	68	24,720	43	366
	Gasoline	0.00	0.00	0.00	0.00	0.00
	Diesel	0.00	0.00	0.00	0.00	0.00
	Propane	0.00	0.00	0.00	0.00	0.00
Subtotal		575,679	100	58,011	100	859
Industrial	Electricity	610,099	46	111,027	71	1,643
	Natural Gas	730,125	54	45,956	29	680
	Gasoline	0.00	0.00	0.00	0.00	0.00
	Diesel	0.00	0.00	0.00	0.00	0.00
	Propane	0.00	0.00	0.00	0.00	0.00
Subtotal		1,340,224	100	156,983	100	2,323
Municipal	Electricity	176,782	69	32,171	82	476
	Natural Gas	13,883	5	874	2	13
	Gasoline	23,266	9	2,094	5	31
	Diesel	40,508	17	3,936	11	58
	Propane	0.00	0.00	0.00	0.00	0.00
Subtotal		254,439	100	39,075	100	578
Transportation	Electricity	1,486	0.00	0.00	0.00	0.00
	Natural Gas	100	0.00	0.00	0.00	0.00
	Gasoline	5,734,119	91	514,103	91	7,609
	Diesel	556,126	9	50,098	9	741
	Propane	25,208	0.00	2,181	0.00	32
Subtotal		6,317,039 ^(a)	100	566,382	100	8,382
Total		10,922,630.00		1,068,287.00		15,810.00

(a) Includes municipal transportation fuel.

Figure 11

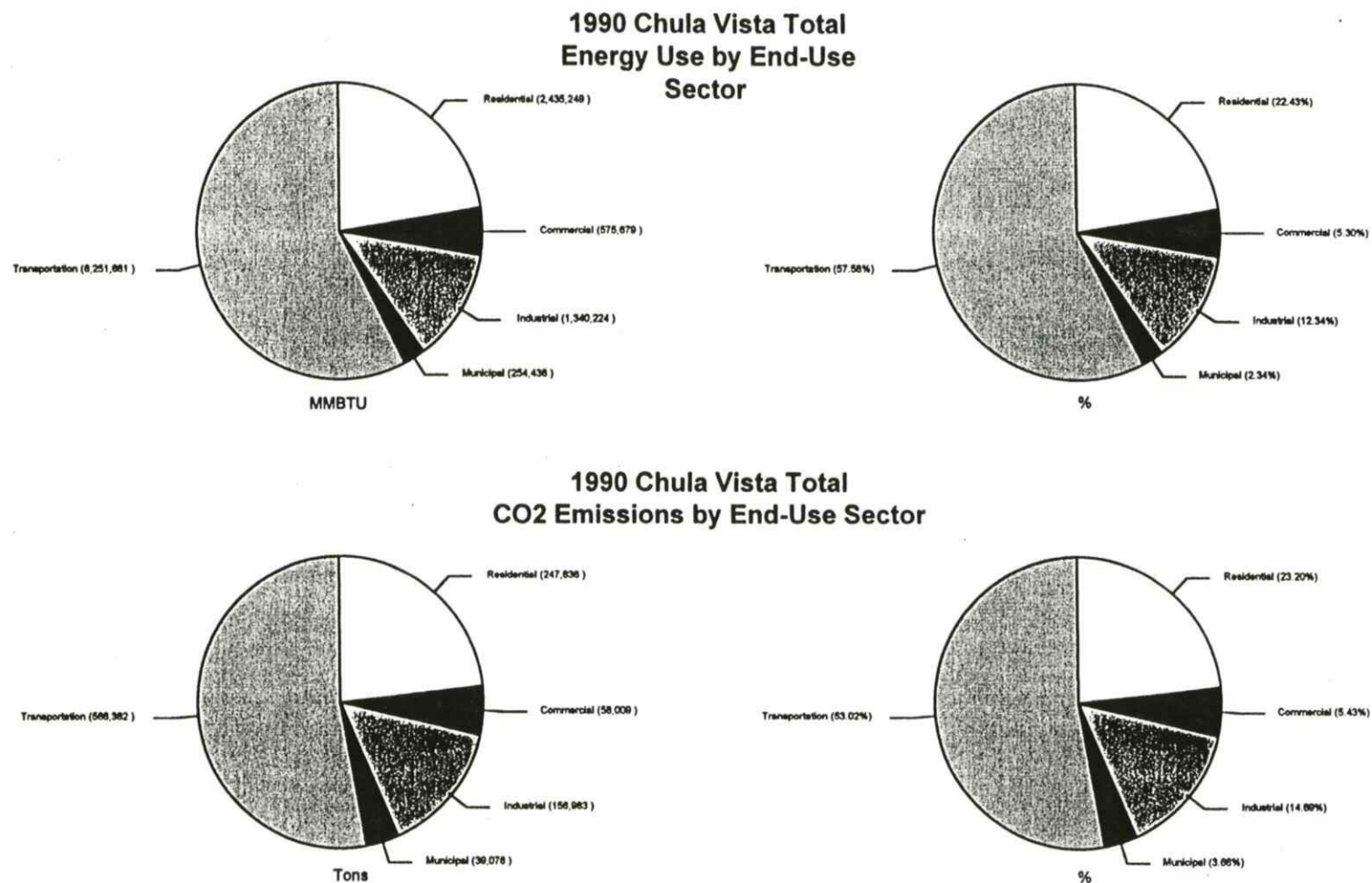
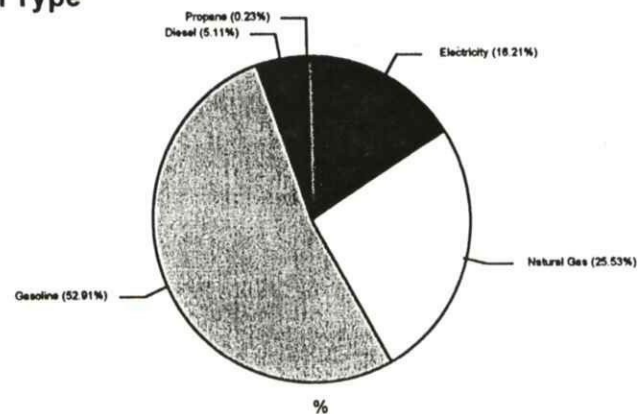
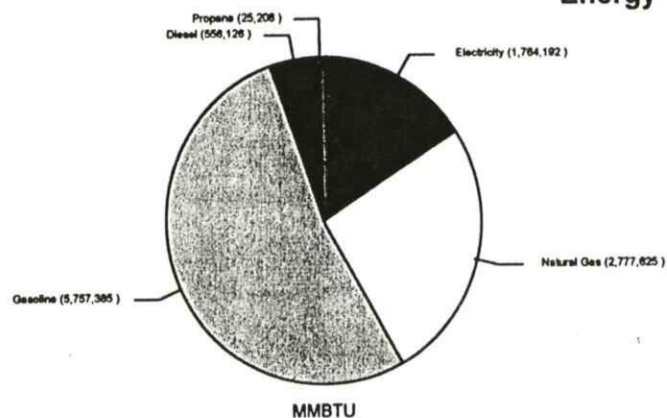


Figure 12

1990 Chula Vista Total Energy Use by Fuel Type



1990 Chula Vista Total CO2 Emissions by Fuel Type

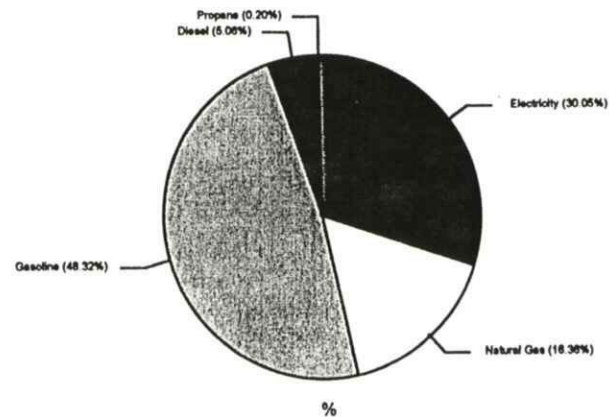
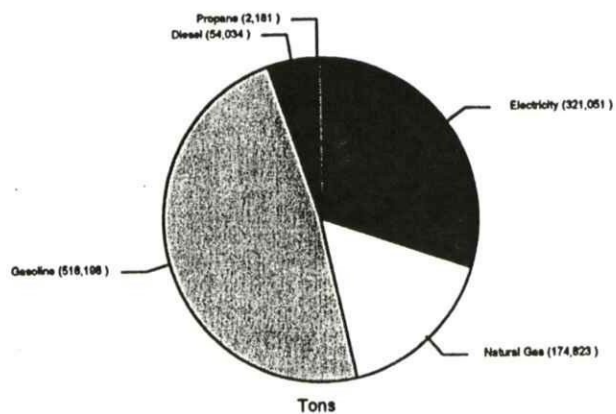
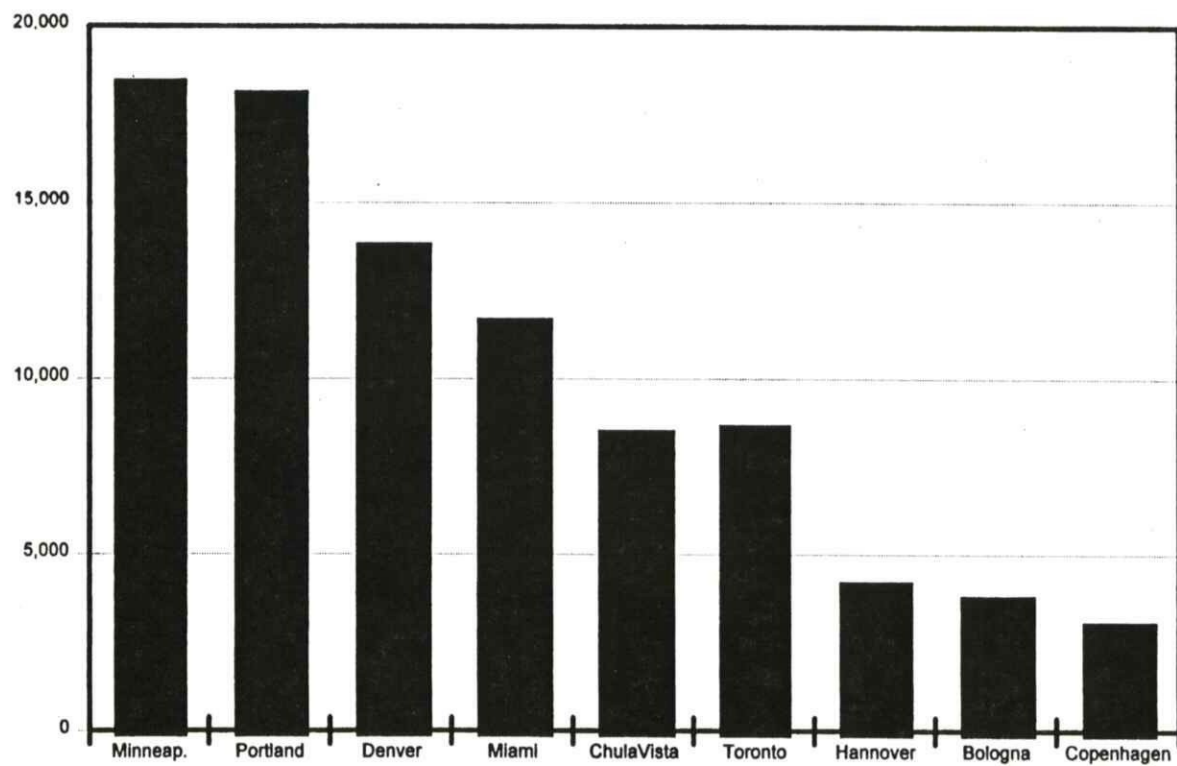


Figure 13

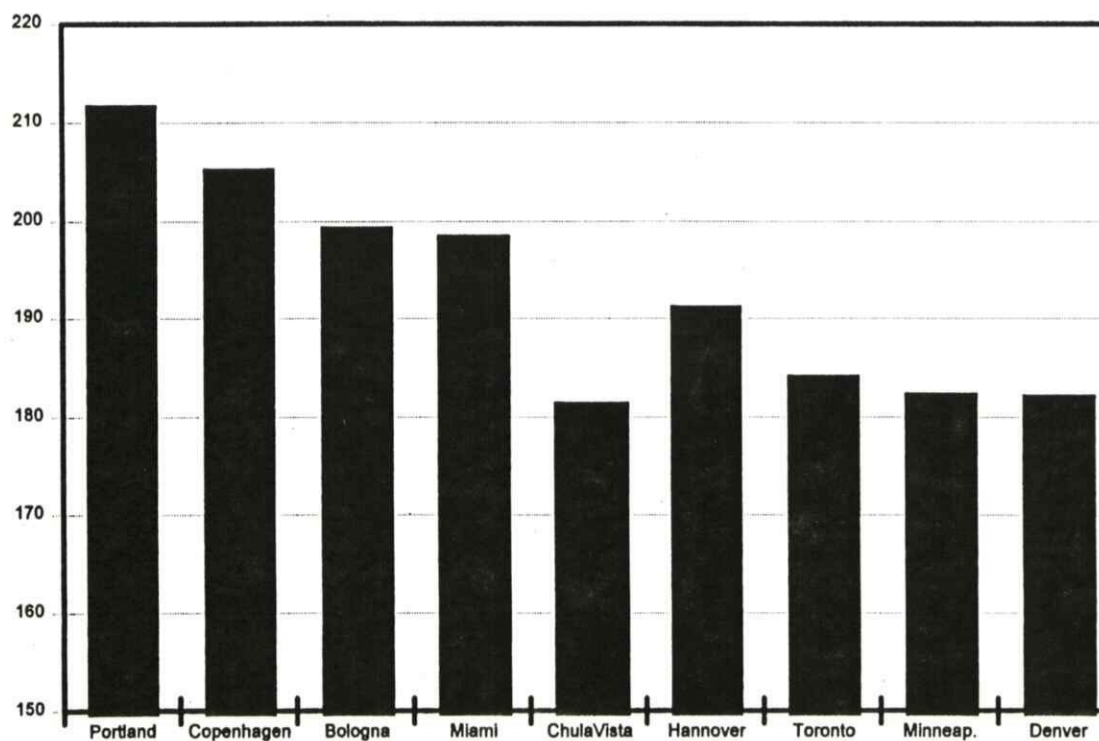
Per Capita CO2 Emissions of 1990 Transportation
Fuel Use of Selected ICLEI Cities
(Lbs/Capita)



Note: Only Hannover and Chula Vista have data for CO2 emissions associated with fuel production and distribution. All other city emission levels have been increased 15% to approximate their fuel production and distribution emissions.

Figure 14

CO2 Intensity of 1990 Transportation Fuel Use
of Selected ICLEI Cities
(Lbs/MMBTU)



Note: Only Hannover and Chula Vista have data for CO2 emissions associated with fuel production and distribution. All other city emission levels have been increased 15% to approximate their fuel production and distribution emissions.

Figure 15

Per Capita CO2 Emissions of 1990 Electric
Use of Selected ICLEI Cities
(Lbs/Capita)

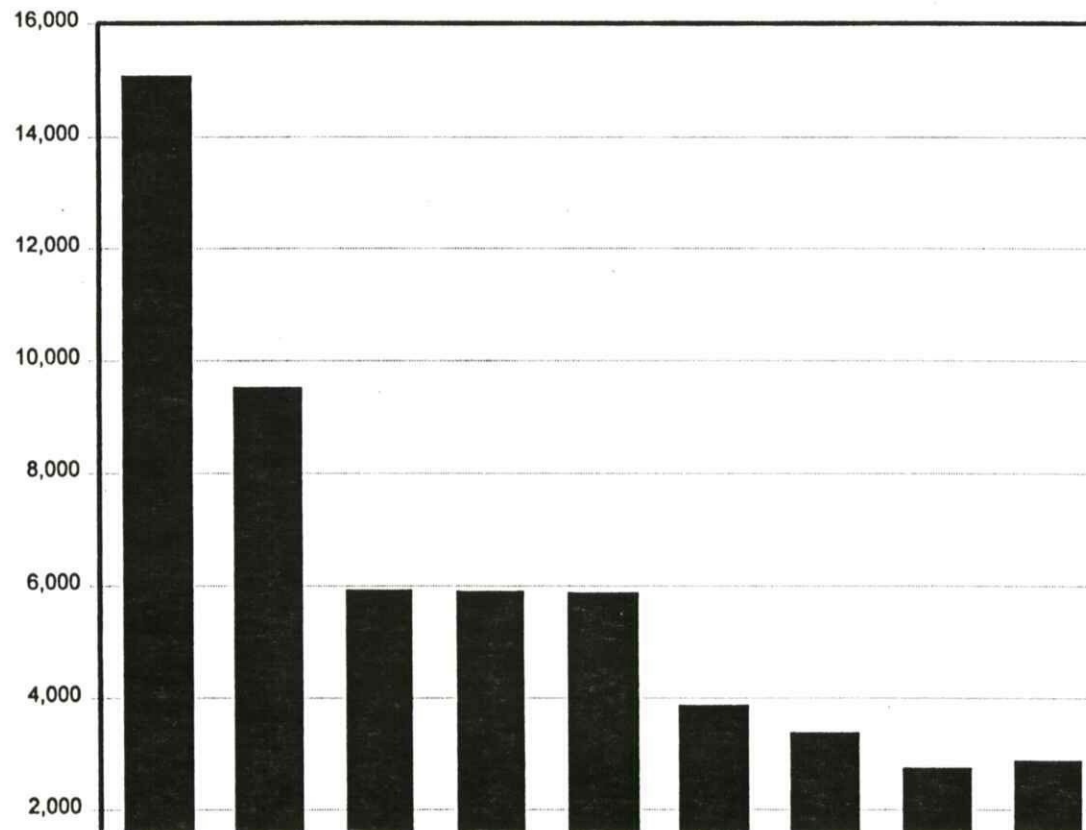
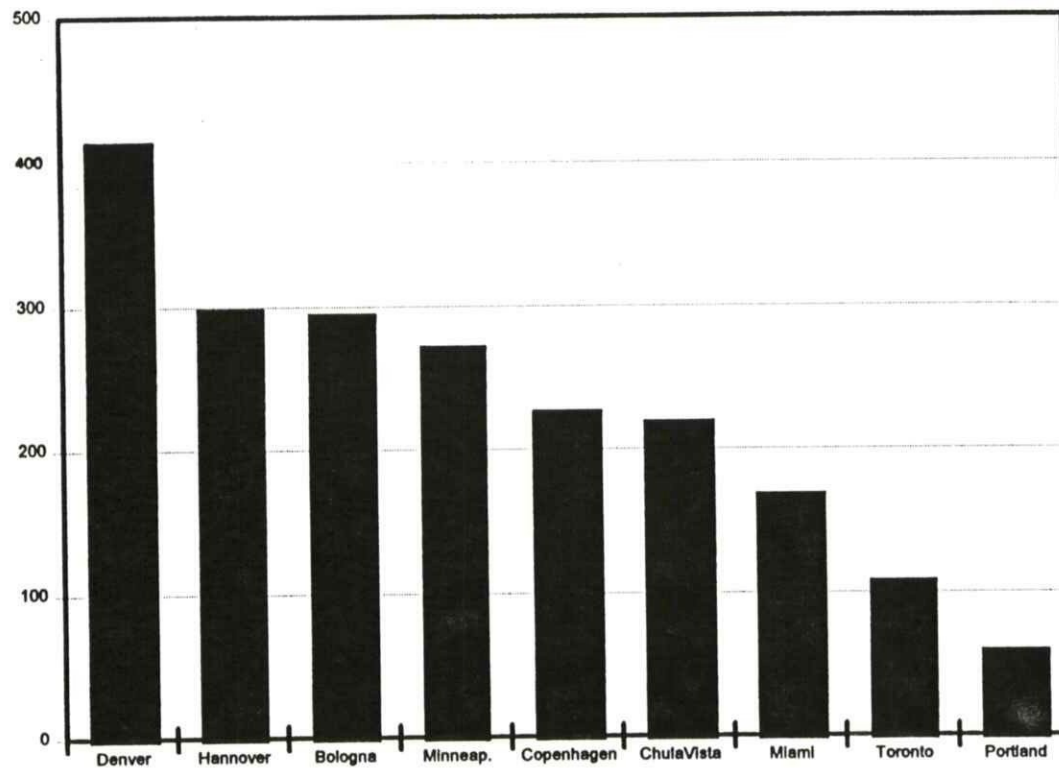


Figure 16

CO2 Intensity of 1990 Electric
Use of Selected ICLEI Cities
(Lbs/MMBTU)



Note: Only Hannover and Chula Vista have data for CO2 emissions associated with fuel production and distribution. All other city emission levels have been increased 10% to approximate their fuel production and distribution emissions.

Appendix C

CO₂ LAND-USE MEASURE APPLICABILITY TO OTAY RANCH

Source: Duane Bazzel, Planning Department

CO ₂ Reduction Measures	Otay Ranch General Development Plan Policies	Otay Ranch Specific Planning Area (SPA) Implementation
<p>1. Increasing mix of residential and complementary nonresidential uses. For example, neighborhood grocery stores close to homes.</p>	<ul style="list-style-type: none"> ■ Locate employment centers close to housing, transit, and HOV lane corridors. ■ Villages should have a mixed-use village core area where higher density residential, civic, and park uses are interspersed with neighborhood, commercial, and office development. ■ Limited convenience commercial may be located outside the village core, but not at Village Entry Streets. These areas will be delineated at the SPA level. 	<ul style="list-style-type: none"> ■ Retail and service commercial located in village core not further than ½ mile from outer limited of residential. Majority of residential within ¼ mile.
<p>2. Increasing mix of residential types, e.g., detached and attached single-family dwellings in the same neighborhood.</p>	<ul style="list-style-type: none"> ■ Includes a variety of uses and housing types within each village to meet the needs of village residents. ■ Limited single-family uses shall be permitted within the Medium-high (MH) category when interwoven with the other uses. These single-family uses shall utilize small-lot concepts consistent with the higher intensity character of the village core. 	<ul style="list-style-type: none"> ■ Each village contains a balance of housing types (i.e., multi-family, attached and detached single-family, etc.)

CO ₂ Reduction Measures	Otay Ranch General Development Plan Policies	Otay Ranch Specific Planning Area (SPA) Implementation
3. Increasing housing density near transit (transit overlay zone).	<ul style="list-style-type: none"> ■ Encourage mixed uses throughout Mixed Use (MU) areas, including residential or office uses above retail uses. ■ Concentrate retail uses near the transit station/stops in MU areas. Orient MU area activities which generate higher volumes of trips toward the transit facilities, rather than toward parking areas. ■ MH residential uses shall be located in the village core, on two or more sides of MU areas. ■ MH residential uses shall be characterized by higher density townhouses, duplexes, and stacked flats with heights ranging from two to four stories, and some single-family uses. ■ The number of units identified in the village core is a minimum and may not be reduced. ■ A transit stop shall be reserved at the SPA level and irrevocably offered for dedication at the Tentative Map level in the village core. ■ Encourage mixed uses throughout MU areas, including residential or office uses above retail uses. ■ Concentrate retail uses near the transit station/stops in MU areas. Orient MU area activities which generate higher volumes of trips toward the transit facilities, rather than toward parking areas. 	<ul style="list-style-type: none"> ■ Residential densities within transit village cores amount to 18.5 DU/acre (gross). Actual project densities within cores amount to a range from 12 DU/acre to 30 DU/acre (net).
4. Encourage infill housing that takes advantage of vacant, already-serviced land in developed areas.	<ul style="list-style-type: none"> ■ Not applicable in new development area. 	N/A

CO ₂ Reduction Measures	Otay Ranch General Development Plan Policies	Otay Ranch Specific Planning Area (SPA) Implementation
<p>5. Increasing employment density near transit, e.g., office integrated with transit stations.</p>	<ul style="list-style-type: none"> ■ The mixed use area is a contiguous pedestrian area which includes the following activities, as listed below: <ul style="list-style-type: none"> □ <i>Retail/Office Uses.</i> Uses such as, but not limited to, retail shops, professional offices, service commercial, restaurants, cinemas, health clubs, entertainment facilities, supermarkets, and studios. Residential uses may be permitted above commercial uses. These uses shall not front on circulation element roads. ■ Encourage mixed uses throughout MU areas, including residential or office uses above retail uses. ■ Concentrate retail uses near the transit station/stops in MU areas. Orient MU area activities which generate higher volumes of trips toward the transit facilities, rather than toward parking areas. ■ Locate commercial uses close to primary village transit stops. ■ The Village Five core shall be designed to accommodate a transit line/transit stop. ■ A transit stop shall be reserved at the SPA level and irrevocably offered for dedication at the Tentative Map level. 	<ul style="list-style-type: none"> ■ Transit stations planned for village core of Villages One and Five.

CO ₂ Reduction Measures	Otay Ranch General Development Plan Policies	Otay Ranch Specific Planning Area (SPA) Implementation
6. Increasing employment density near shopping, e.g, multi-use commercial centers.	<ul style="list-style-type: none"> ■ The MU area is a contiguous pedestrian area which includes the following activities, as listed below: <ul style="list-style-type: none"> □ <i>Retail/Office Uses.</i> Uses such as, but not limited to, retail shops, professional offices, service commercial, restaurants, cinemas, health clubs, entertainment facilities, supermarkets, and studios. Residential uses may be permitted above commercial uses. These uses shall not front on circulation element roads. ■ Encourage mixed uses throughout MU areas, including residential or office uses above retail uses. ■ The main street theme shall organize commercial, office, and public/quasi-public uses in a linear fashion along a small scaled, tree-lined street with parking on both sides. While some parking may be visible from the street, it would be predominantly located to the rear of the buildings. Arcades, alleys, patios, and similar spaces will provide pedestrian access from rear parking areas to the front entrances. 	<ul style="list-style-type: none"> ■ MU use commercial and residential designed within the village cores for Villages One and Five.
7. Encourage employment infill with focused economic development incentives on vacant, serviced nonresidential lands.	<ul style="list-style-type: none"> ■ Not applicable as new development area. 	N/A

CO ₂ Reduction Measures	Otay Ranch General Development Plan Policies	Otay Ranch Specific Planning Area (SPA) Implementation
<p>8. Traditional neighborhood development (TND) emphasizing pedestrian/transit connections.</p>	<ul style="list-style-type: none"> ■ Pedestrian and bicycle routes shall connect the more distant portions of a village to the village core. Generally, such routes shall be collected with streets, although connections may be provided along transit corridors or within greenbelts. ■ Promenade Streets shall extend from secondary areas into the village core to accommodate pedestrian and bike access. ■ Non-auto circulation systems, such as pedestrian walkways and bike ways, shall be provided between villages. Where appropriate and feasible, a grade separated arterial crossing should be provided to encourage pedestrian activity between villages. ■ Village cores should be centrally located, within approximately ¼ mile of the majority of a village's population. ■ The design and location of residential areas shall complement the pedestrian-friendly environment. ■ Public access spaces, such as a plaza, town square, park, or town hall or community building, shall be provided in MU areas. Public access spaces may be privately owned. ■ Villages shall provide for a variety of modes of transportation, including walking, automobiles, bus, rail, specialized transit, and bicycles. ■ Transportation components, such as park-and-ride facilities, bus stops, and the pedestrian walkways and bike ways, shall be sited and designed to facilitate connections between transportation modes. ■ Participate in programs for employees to encourage their employees to utilize alternate forms of transportation. 	<ul style="list-style-type: none"> ■ Village street layout planned with semi-grid pattern. Pedestrian connections emphasized throughout.

CO ₂ Reduction Measures	Otay Ranch General Development Plan Policies	Otay Ranch Specific Planning Area (SPA) Implementation
	<ul style="list-style-type: none"> ■ Develop patterns of land-use which will allow the elimination of automobile trips and encourage pedestrian movement through pedestrian-friendly environments and proper land-use mix. ■ The bicycle and pedestrian path systems should provide for a safe continuous pedestrian and bicycle circulation system to all parts of villages. ■ Bicycle storage facilities should be provided within village cores, at transit and bus stops. 	
<p>9. Locate schools/parks for efficient access.</p>	<ul style="list-style-type: none"> ■ Connect open spaces, schools, parks, and neighborhoods with convenient and safe pedestrian walkways and bikeways. ■ The MU area is a contiguous pedestrian area which includes the following activities, as listed below: <ul style="list-style-type: none"> □ <i>Elementary Schools.</i> Elementary schools shall be located within or adjacent to the MU area, where population warrants. However, elementary schools shall not be located so as to disrupt the contiguous retail uses. ■ Public access spaces, such as a plaza, town square, park, or town hall or community building, shall be provided in MU areas. Public access spaces may be privately owned. ■ Transportation components, such as park-and-ride facilities, bus stops, and the pedestrian walkways and bike ways, shall be sited and designed to facilitate connections between transportation modes. ■ Pedestrian, bicycle, and vehicular access should be provided to East Lake and adjacent villages. 	<ul style="list-style-type: none"> ■ Elementary schools located near core of villages. ■ Both neighborhood and pedestrian-size parks strategically sited throughout Village One and Five.

CO ₂ Reduction Measures	Otay Ranch General Development Plan Policies	Otay Ranch Specific Planning Area (SPA) Implementation
10. Pedestrian/bike orientation. Provide direct, short, convenient linkages for pedestrian and bicyclists.	<ul style="list-style-type: none"> ■ Locate land uses and design structures to foster a pedestrian activity. ■ Provide pedestrian links extending from surrounding neighborhoods directly to the village core. ■ Provide employee services within walking distance (i.e., banking child care, restaurants, etc.) of employees. ■ Provide secure bicycle storage facilities at transit stops, and employment and retail centers. ■ Convenient bicycle access shall be provided to transit nodes. 	<ul style="list-style-type: none"> ■ Semi-grid street patterns as well as openings at ends of internal cul-de-sacs provide pedestrian connections throughout Villages One and Five.
11. Transit orientation. Provide direct, short, convenient linkages to transit.	<ul style="list-style-type: none"> ■ Arterials and transit stops should be linked by a network of sidewalks and bike paths. ■ Transit stops should be within ¼ mile of village core residential areas and within ¼ mile of village core activity centers. ■ Provide housing within walking distance of transit stations. ■ Convenient pedestrian access shall be provided to all transit nodes. 	<ul style="list-style-type: none"> ■ Transit stations planned for the village cores. Street and pedestrian links planned for access to the core areas.

CO ₂ Reduction Measures	Otay Ranch General Development Plan Policies	Otay Ranch Specific Planning Area (SPA) Implementation
12. Solar orientation for passive and/or active use.	<ul style="list-style-type: none"> ■ Prepare a non-renewable energy conservation plan for each SPA. This plan shall identify measures to reduce the consumption of non-renewable energy resources by feasible methods, including, but not requiring, and not limited to the following: <p style="margin-left: 20px;">Building design and use:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Building orientation <input type="checkbox"/> Use of better-insulated buildings <input type="checkbox"/> Use of earth sheltered design <input type="checkbox"/> Use of energy efficient appliances <input type="checkbox"/> Use of solar energy systems <p style="margin-left: 20px;">Alternative energy sources:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Solar <input type="checkbox"/> Wind <input type="checkbox"/> Hydro-electric <input type="checkbox"/> Biomass (wood, chaparral, etc.) 	<ul style="list-style-type: none"> ■ Solar access has not been a feature in the physical planning for Villages One and Five, however, SPA plan policies related to solar access can be applied to siting of future structure.
13. Vegetative cooling via shading to reduce building space cooling requirements.	<ul style="list-style-type: none"> ■ Not addressed at the GDP level. 	<ul style="list-style-type: none"> ■ SPA plan policies can be applied to address this.
14. Light-colored exterior surfacing that reflects heat to reduce.	<ul style="list-style-type: none"> ■ Not addressed at the GDP level. 	<ul style="list-style-type: none"> ■ SPA plan policies can be applied to address this.
15. Carbon-absorbing landscaping planted as a CO ₂ sink (rather than purely for shading).	<ul style="list-style-type: none"> ■ Not addressed at the GDP level. 	<ul style="list-style-type: none"> ■ SPA plan policies can be applied to address this.

CO ₂ Reduction Measures	Otay Ranch General Development Plan Policies	Otay Ranch Specific Planning Area (SPA) Implementation
16. On-site energy resource use. For example, ground water, high efficiency space condition technologies, etc.	<ul style="list-style-type: none"> ■ Prepare a non-renewable energy conservation plan for each SPA. This plan shall identify measures to reduce the consumption of non-renewable energy resources by feasible methods, including, but not requiring, and not limited to the following: <li style="margin-left: 20px;">Alternative energy sources: <li style="margin-left: 20px;"><input type="checkbox"/> Solar <li style="margin-left: 20px;"><input type="checkbox"/> Wind <li style="margin-left: 20px;"><input type="checkbox"/> Hydro-electric <li style="margin-left: 20px;"><input type="checkbox"/> Biomass (wood, chaparral, etc.) 	<ul style="list-style-type: none"> ■ Energy conservation plan yet to be prepared.
17. Pedestrian oriented street design, including direct, short, convenient linkages.	<ul style="list-style-type: none"> ■ Land-uses, roads, and building shall be designed and located to encourage walking between uses and foster a pedestrian scale. ■ Located land-uses and design structures to foster a pedestrian activity. ■ Provide pedestrian links extending from surrounding neighborhoods directly to the village core. ■ Connect open spaces, schools, parks, and neighborhoods with convenient and safe pedestrian walkways and bikeways. 	<ul style="list-style-type: none"> ■ Semi-grid pattern of streets and pedestrian links to be village core are designed into each village.
18. Integrated street networks (multi-modal streets with high connectivity)	<ul style="list-style-type: none"> ■ Land-uses, roads, and buildings shall be designed and located to encourage walking between uses and foster a pedestrian scale. ■ Streets shall balance the needs of pedestrians, buses, and automobiles. Intersections shall encourage pedestrian movement, reduce the number of turning lanes (where feasible), reduce auto speed while ensuring public safety, and provide for emergency vehicle access. 	<ul style="list-style-type: none"> ■ Street system design emphasizes multi-modal (e.g., autos, buses, golf carts, bicycles, and trolley).

CO ₂ Reduction Measures	Otay Ranch General Development Plan Policies	Otay Ranch Specific Planning Area (SPA) Implementation
19. Revise minimum/appropriate parking requirements, including shared parking and disincentives for single-occupant autos.	<ul style="list-style-type: none">■ Encourage joint use of parking facilities by uses which have differing peak hours. A reduction of required parking spaces may be permitted for shared parking programs, implemented with a joint use agreement executed and approved at the time of SPA approval.■ Allow preferential (free or reduced fee) parking for carpools and vanpools, near entrances to activity centers.■ Joint parking is strongly encouraged for proximate uses. Retail, office, entertainment, and some housing could share parking areas and quantities.	<ul style="list-style-type: none">■ Zoning requirements for core areas where parking areas will be located have not been addressed in the SPA plan yet.

Appendix D

NON-ENERGY BENEFITS OF EFFICIENCY IMPROVEMENTS

Source: adapted from Mills, 1994

Why Consider Non-energy Benefits?

This appendix describes energy-efficient technologies that deliver equivalent energy service levels (compared to inefficient counterparts) and also offer non-energy benefits for consumers. The objective is to more strongly emphasize non-energy benefits in the assessment and marketing of energy efficiency.

Although direct economic benefits (cost-effectiveness) have been the mainstay in arguments for energy efficiency, amounting to as much as several hundred billion dollars of prospective annual savings at the national level, the relatively few dollars that a single consumer stands to gain don't provide as strong a motivation. In fact, it is often the non-energy benefits that motivate (or can be used to promote) decisions to adopt energy-efficient technologies. A striking example is the rapid penetration of microwave ovens into the housing stock over the past decade. While energy savings from microwave ovens can be substantial, the non-energy amenity and convenience factors appear to have driven consumer adoption.

The existence and consumer awareness of non-energy benefits is also important to utilities, energy service companies, and others seeking to "sell" efficiency by drawing attention to the collateral benefits. While it is common to speak of the ways in which energy-efficient technologies help provide equivalent services at lower costs, non-energy benefits can actually add value or otherwise enhance the energy services delivered by efficient technologies. In addition, where certain market segments are not sensitive to economic arguments (e.g., in the proverbial split-incentive "landlord-tenant" situation), non-energy benefits can assume a special importance.

A Framework For Characterizing Non-energy Benefits

Discussion of non-energy benefits often focuses on the societal level. Commonly cited examples of such benefits include enhanced energy security through reduced oil imports, job creation [considered

a cost by economists], local economic development induced by large-scale efficiency programs, enhanced international competitiveness, and reduced pollution.

A different class of non-energy benefits emerge at the level of the individual energy consumer. Few efforts have been made to systematically describe and evaluate consumer non-energy benefits (see, e.g. Rashkin et al. 1993) . Many documents have parenthetically noted individual items--or use non-energy benefits to promote a particular type of energy--but do not take a comprehensive view. Rashkin et al.'s effort to perform a literature search on non-energy economic benefits in buildings concluded that there are many data gaps and that further research is required. Non-energy benefits may defy economic quantification.

Seven categories of benefits are considered in this paper, as shown in Tables 1 and 2. Benefits are defined as improvements in a given category as compared with the attributes of the base-case (relatively inefficient) technology.

- *Improved indoor environment, comfort, health, and safety*--applies to measures that reduce indoor air pollution, enhance thermal comfort, or improve factors associated with health or safety, such as the ability of exhaust heat recovery systems to decrease the likelihood of insufficient ventilation rates at certain times of day or in certain parts of a building.
- *Reduced noise*--applies to measures that lead to reduced noise levels, such as the sound-insulating value of highly-efficient windows.
- *Labor and time savings*--applies to measures that have lower maintenance costs, improve productivity because workers have an improved environment, or that reduce the amount of time required to do a task (exemplified by the more rapid cooking time offered by microwave ovens).
- *Improved process control*--applies to measures that enhance the control of a process, such as the use of variable-speed motors to improve quality and uniformity of a manufacturing procedure or halogen-lamp cooktops to improve control over cooking.
- *Increased amenity or convenience*--applies to measures that augment the quality of energy services or the functionality of the end-use device. For example, electronic ballasts eliminate flicker and noise from lighting systems.

Table 1
**MATRIX OF NON-ENERGY BENEFITS FOR SELECTED
ENERGY-EFFICIENT TECHNOLOGIES**
(See Table 2 for descriptions of the bullets)

	Improved Indoor Environment, Comfort Health, Safety	Reduced Noise	Labor and Time Savings	Improved Process Control	Increased Amenity or Convenience	Water Savings and Waste Minimization	Direct and Indirect Economic Benefits (Down- sizing)
Drivepower							
Variable-speed drives		✓	✓	✓			
Efficient motors			✓				✓
Efficient belt drives	✓		✓				
Surfactant additives		✓	✓				✓
Lighting							
Halogen lamps			✓		✓		✓
IR halogen lamps	✓		✓				✓
Compact fluorescent lamps			✓		✓		✓
Electronic ballast	✓	✓	✓	✓	✓		✓
CFL or LED exit sign	✓	✓	✓				✓
Daylighting	✓		✓	✓	✓		✓
Occupancy sensors	✓		✓		✓		✓
Windows							
Highly insulating windows	✓	✓			✓		✓
Solar-control glazings	✓	✓			✓		✓
Electrochromic glazings	✓			✓	✓		✓
HVAC							
Radiant cooling	✓	✓		✓			✓
Airvest	✓	✓	✓				✓
Exhaust heat recovery	✓			✓			✓
Induced-draft furnaces	✓	✓					
Condensing furnaces	✓	✓					
Variable-speed furnace blower	✓	✓					
Appliances							
Horizontal axis clothes washer					✓	✓	
Low-flow showerhead, faucet						✓	
Efficient dishwasher						✓	
Microwave oven			✓		✓		
Microwave clothes dryer		✓		✓	✓		
Efficient unvented appliances	✓						
Other							
Envelope insulation	✓	✓			✓		✓
Laptop computer (compared to desktop)	✓	✓	✓		✓		✓
Energy monitoring and control system	✓		✓	✓	✓		

Table 2
**MATRIX OF NON-ENERGY BENEFITS FOR SELECTED
ENERGY EFFICIENT TECHNOLOGIES**

	Improved Indoor Environment, Comfort Health, Safety	Reduced Noise	Labor and Time Savings	Improved Process Control	Increased Amenity or Convenience	Water Savings and Waste Minimization	Direct and Indirect Economic Benefits (Down-Sizing)
Drivepower							
Variable -speed drives		Quieter at lower speed	Longer drive life	Optimal speed can be chosen			
Efficient motors			Longer life (cooler operation)				Downsizing
Efficient belt drives	Higher reliability		Longer life				
Surfactant additives (low viscosity additive to reduce frictional and pumping losses in circulating fluids, e.g., in hydronic systems)		Reduced chambering in pumps and pipes	Reduced wear and tear on valves				Pump downsizing
Lighting							
Halogen lamps			Longer lasting than incandescent		Distinctive light quality		HVAC interaction
IR halogen lamps	50x less UV radiation than standard halogen		Longer lasting than incandescent				HVAC interaction
Compact fluorescent lamps			Longer lasting than incandescent		Cooler, less inconvenience and risk of injury during replacement		HVAC interaction
Electronic ballast	No perceptible flicker, facilitates daylighting and task/ambient VDT lighting	No hum	Reduced lamp lumen depreciation	Dimmability	Smaller, lighter		HVAC interaction
CFL or LED exit sign	Less likely to burn out	No ballast hum if LED	Longer lasting than regular exit signs				HVAC interaction
Daylighting	Various health benefits		Daylighting system longer lasting than luminaries	Can control illuminance with dimmable ballast	Views, excellent color rendering		HVAC interaction
Occupancy sensors	Outdoor security lighting		Extends lamp service life in certain applications		Automatic on/off switching		HVAC interaction

Table 2 Continued

	Improved Indoor Environment, Comfort Health, Safety	Reduced Noise	Labor and Time Savings	Improved Process Control	Increased Amenity or Convenience	Water Savings and Waste Minimization	Direct and Indirect Economic Benefits (Down-Sizing)
Windows							
Highly insulating windows	UV protection (eyes, skin) warmer surfaces; reduced condensation, possible EMI shielding, resists fire	Sound barrier if more than one pane, low infiltration			UV protection for furnishings, artwork, textiles		HVAC interaction
Solar-control glazings	UV protection	Sound barrier if more than one pane, low infiltration			UV protection for furnishings, artwork, textiles		HVAC interaction
Electrochromic glazings	Wind can be made opaque for privacy			Dynamically tunable transmittance	Reduce glare, possible EMI shielding, resists fire		HVAC interaction
HVAC							
Radiant cooling	Enhanced thermal comfort	No ventilation noise		Better control of thermal environment			Reduced space required for ventilation system
Airvest (small, low-power fan worn on chest of worker in spray booth)	Reduced worker exposure to airborne chemicals	Decreased ventilation rate	Improved worker health				Decreased fan capacity
Exhaust heat recovery	Lower probability of insufficient air change rates			Improved control over air circulation and exchange rates			HVAC interaction
Induced-draft furnaces	Safer; reduced probability of backdrafting and spillage of pollutants	Quieter operation					
Pulse combustions, condensing furnaces	Safer with sealed combustion	Quieter operation					
Variable-speed blower on furnace	Less drafts	Quieter operation					
Appliances							
Horizontal axis clothes washer					Less detergent	Less water per kg clothes	
Low-flow showerheads, faucets						Lower flow	
Efficient dishwasher						Less water	
Microwave oven			Reduced cooking time		Easier cleaning		

Table 2 Continued

	Improved Indoor Environment, Comfort Health, Safety	Reduced Noise	Labor and Time Savings	Improved Process Control	Increased Amenity or Convenience	Water Savings and Waste Minimization	Direct and Indirect Economic Benefits (Down-Sizing)
Microwave clothes dryer (or dryer with moisture sensor shut-off control)		No or low amount of tumbling		Final moisture content controllable	Faster, cooler, automatic shut-off		
Efficient unvented combustion appliances	Reduced indoor pollution						
Other							
Envelope insulation	Warmer interior surfaces	Reduced noise transmission			Possible increased home resale value		HVAC interaction
Laptop computer (compared to desktop)	Many times less EMF than desktop computers	Quite, if no fan	Usable during travel, etc.		Smaller desktop footprint		HVAC interaction
Energy monitoring and control system (EMCS)	Early detection of equipment failures or performance problems		Enables remote targeted monitoring and maintenance	Enhanced control of HVAC, lighting, etc.	Centralized point of control and monitoring		

- *Water savings and waste minimization*--applies to measures that lead to less water use, such as horizontal-axis clothes washers, or reduce waste of other resources .
- *Direct and indirect economic benefits from downsizing of equipment*--applies to measures such as HVAC equipment (direct) and distribution system (indirect) downsizing made possible as a result of reduced solar gain through windows, from lights and plug loads, etc.

The premise that non-energy benefits should be considered in energy planning rests on the validity of a total or societal resource cost test. Ignoring any component (cost or benefit) violates this test. We recognize that when improperly applied, energy-efficient technologies may not maintain energy service levels and can have other undesirable side-effects (e.g. light quality or noise problems that can occur with compact fluorescent lamps), but it is not the aim of this paper to evaluate such impacts.

Highly Insulating Windows

Energy-efficient windows offer a wide array of non-energy benefits. If the attention given to them in the trade literature and advertising is an indication, the window industry believes these benefits are crucial to consumer adoption. Highly insulating windows are among the most successful energy-efficiency technologies. Today, for example, low-emissivity windows represent about 33% of new residential window sales and 17% of commercial building sales.

Non-energy benefits for windows include reduced transmission of radiation that causes fading, and improved thermal comfort (discussed below). Low-emissivity and electrochromic windows may also provide shielding against electromagnetic radiation that can interfere with electronic devices such as wireless communications equipment and inhibit electronic spying. Efficient windows make homes safer in the event of fire. Double-glazed windows were cited as one reason that a home survived a fire in which virtually every other home in the neighborhood was destroyed (Fleeman 1993). Thermal shock due to the expansion of the window panes causes some of the outer panes to shatter--providing a point of entry for the fire into the home--but the interior panes remain intact. Reduced sound transmission is another benefit offered by multiple panes of glass (and thicker glass) or reduced infiltration around windows. Reduced condensation can be achieved via reduced thermal conductivities and lack of thermal bridges in the window frame. Efficient glazing systems provide effective acoustical insulation.

Reduced Damage to Furnishings

Most efficiency options for windows decrease the transmission of destructive radiation. This radiation can damage home furnishings, artwork, etc. Damage (defined here as change in coloration) increases exponentially with increasing frequency and is most severe in the UV spectrum, but can be caused by radiation that extends well into the visible range. Each pane of glass filters some of the damaging wavelengths, so even double-glazed windows are an improvement over single-glazed ones. Low-emissivity coatings offer additional reductions.

Enhanced Thermal Comfort

Energy-efficient windows also enhance thermal comfort. Window temperatures contribute to a building's overall mean radiant temperature (MRT), a surface weighted average temperature of building surfaces that can "see" a given human occupant. Single-glazed windows will result in interior glass surface temperatures close to outdoor temperatures and will contribute to producing winter MRTs that are lower than the interior air temperature. This situation contributes to thermal discomfort both in hot and cold climates.

Part of the problem stems from two conflicting standards. For thermal comfort, ASHRAE Standard 55-1992 (Thermal Environmental Conditions for Human Occupancy) recommends that radiant asymmetry in the horizontal direction should not exceed 10°C (18°F) for subjects standing two feet from a window. For energy efficiency, ASHRAE Standard 90.2, recommends window U-values of 0.87 (R1.1) for much of the southern and eastern United States. St. Louis and Washington, D.C. are among the colder cities in this region.

The ASHRAE recommended thermal performance can be achieved by a single glazed window in a vinyl frame. For the comfort standard, if all other surfaces in the room are 21°C (70°F), the glass temperature must not fall below 7.8°C (46°F) if comfort is to be maintained. This discomfort condition will occur for 1100 hours during the heating season (22% of the hours) for a southfacing single-glazed window in St. Louis. With double glazing and a 1/4-inch airgap, the number of annual discomfort hours drops to 35 (<1% of the hours).

Energy Efficient Lighting

Of all end uses, efficient light technologies have perhaps the highest incidence of non-energy benefits. The benefits exist in the areas of enhanced visual environmental facts, labor productivity, and various amenities. In fact, one of the (non-energy) factors that helped create the market for electric lighting a century ago was the greatly reduced fire hazard offered by electric versus gas lights. Modern efficient lighting technologies can go a long way towards reducing glare and enabling better visual performance, while generating significant indirect HVAC energy use and capital-cost savings.

Increased Light Quality and Longevity

The rapid increase in popularity of energy-saving halogen lamps in homes and businesses is a striking modern-day case in point of how new energy-efficient technologies can be propelled into the market by factors other than their energy saving qualities. The energy-saving benefits are overshadowed in the minds of most consumers by the light quality (directionality, sparkle) provided by halogen sources. Halogen luminaries have distinguished themselves in the marketplace by assuming the status of high-end furniture (rather than "lamps" purchased strictly for their functional value).

Exit signs fitted with compact fluorescent lamps (CFL) or light-emitting diodes (LEDs) are other examples of energy-efficient lighting technologies that offer non-energy benefits (Tucker 1992). Both of these light sources last much longer than the incandescent lamps they are designed to replace. This translates not only into labor and materials savings but also into an increased likelihood that the signs will be operating properly in a time of need – burned-out incandescent exit signs are an uncomfortably common sight. The market share of CFL exit signs has already reached 100% in several European countries (Mills 1993). The longer life of CFLs also has shown value in the residential sector. Rebate programs in Sweden found that senior citizens were more heavily represented among lamp buyers (-30% of the total) than their share of the general population, presumably because of the greatly reduced inconvenience and risk of falling during lamp changes, among other factors (Mills 1993). The labor costs of lamp changes in some environments (stairwells, high-security areas, etc.) can be quite high.

Benefits for Health

High-frequency electronic ballasts -- one of the most successful energy-efficient technologies -- offer numerous non-energy benefits, spanning most of the categories in Table 1. By virtue of their nonflickering operating, electronic ballasts probably have positive health impacts compared to standard magnetic ballasts (Wilkins 1991). For example, in a double-blind study in the United Kingdom, office workers with high-frequency ballasts had less than half the incidence of headaches and eyestrain as their co-workers in offices with normal 50Hz ballasts. The irrational and overwhelming fear of public places (agoraphobia) and other manifestations of anxiety have also been observed to diminish when subjects switch to high-frequency lighting. At frequencies at or below 60Hz, flickering light can trigger epileptic seizures in sensitive individuals.

Daylighting (also facilitated by electronic ballasts linked to photocells) is another energy-saving lighting strategy that has many desirable non-energy attributes. According to a review of recent research cited by Wilkins (1991), people prefer to work by daylight, and the absence of windows has been correlated with an increase in transient psychosis in hospitals and an increase in absenteeism in schools and factories. In humans, levels of melatonin appear to be influenced by light and may help explain seasonal affective disorder (SAD), a type of psychological and physiological depression that affects about 5% of the population.

Space Conditioning, Ventilation, and Indoor Air Quality

While indoor air quality and energy efficiency have often been simplistically portrayed as mutually exclusive, various field studies have found complex correlations between ventilation rates and indoor concentrations of pollutants such as radon, formaldehyde, respirable suspended particles, polycyclic aromatic hydrocarbons, nitrogen dioxide, carbon monoxide, carbon dioxide, and water vapor (Turk et al, 1987a,b; Turk et al, 1988). There are in fact cases in which improvements in efficiency lead to reductions in indoor pollutants. Moreover, extremely energy-efficient air-handling is consistent with superlative indoor air quality if properly designed and controlled. Modern control options include real-time measurement of CO₂, CO, formaldehyde, and other pollutants.

Reducing Contaminants from Unvented Combustion Appliances

An unvented combustion appliance (e.g., some stovetops and kerosene heaters) will introduce fewer pollutants to the indoor environment if it operates efficiently. As an extreme example, poorly-controlled central heating in multi-family units may drive tenants to use their cooktops for space heating. This was documented for three public housing authorities, where monthly gas usage was up to five times higher in winter in buildings where central space and water heating was provided by oil-fired boilers (Greely et al, 1987). In one location (400 housing units), heating control valves and steam traps were installed to save energy, and – as a side effect – the seasonal fluctuation of cooking gas consumption decreased about threefold compared to peak pre-retrofit levels. Reduced release of gas combustion products into these apartments is a potentially important non-energy benefit of the heating controls retrofit.

Eliminating Backdrafting and Spillage of Combustion Products

Advanced furnaces offer particular indoor air quality benefits. In furnaces that rely on a thermally-induced stack effect to transport combustion products through the flue and outside the structure, certain outdoor conditions (temperature or wind) can cause backdrafting and spillage of pollutants into the living space. This problem can also be triggered by other ventilation devices in a home (e.g., stovetop or bathroom fans), which create a negative pressure across the building envelope. Efficient forced-draft furnaces can counteract these effects. Condensing combustion furnaces eliminate the need for a stack altogether.

Improved Ability to Reduce Airborne Contaminants

Two hypothetical homes (with and without heat-recover ventilation) have comparable annual average air change rates of about 0.5 air changes per hour (ach), but the scatter is much wider in the home without mechanical ventilation, and a large number of hours occur with rates considered low. For the naturally ventilated home, there are 600 hours per year that the ventilation rate is under 0.25 ach. For the mechanically ventilated home, there would be no severe under-ventilated periods as long as the system is on.

Heat-recovery ventilation can help avoid brief periods of low ventilation rates that can cause high concentrations of indoor pollutants (Wallman et al, 1987). Not only is this of value in reducing exposure to indoor pollutants, but it also can reduce the likelihood of damaging water vapor levels. Problems with

elevated water vapor levels in bedrooms were lower in the heat-exchanger homes monitored by Turk et al (1987b), than in a group of control homes. There were more complaints about mold and mildew in the control homes than in the efficient homes (Vine 1987). The air-to-air heat exchangers achieved better mixing of air.

Decoupling Ventilation from Space Conditioning

Strategies that save energy while reducing the amount of recirculated air (e.g., with radiant cooling or economizer cooling) may play a role in eliminating certain pathways of disease transmission. Evidence comes from a controlled study that compared the incidence of febrile acute respiratory diseases (cold with a fever, caused by viral infection of the lungs) in army trainees in two sets of barracks (Brundage et al, 1988). HVAC systems in the "modern" barracks recirculated approximately 95% of the air and provided three air changes per hour. In the "old" barracks, windows and ceiling exhaust fans were the primary source of ventilation, and the HVAC systems recirculated only 50% of the air. During 2.6 million trainee-weeks during the 1982-1986 period, there were more than 14,000 acute respiratory disease hospitalizations among soldiers living in the two sets of barracks. The ratio of new-to-old barrack hospitalization rates was 1.51:1, translating into about 2,700 more admissions among occupants of the barracks that used predominately recirculated air.

Radiant cooling, a strategy widely used in Europe but little known in North America, achieves energy savings by separating the tasks of providing cooling and fresh air. In a radiant cooling system, cold water is circulated through ceilings, both cooling the air and creating a reduced mean radiant temperature in the occupied space. Outside air can be provided separately (at 80 to 90% lower volumes, since heat transfer is not an objective) and recirculation is unnecessary. Energy savings are achieved because transporting coolth by pumping water is much less energy intensive than using air. In addition to substantial energy savings, non-energy benefits of radiant cooling include avoiding the spread of odors or other airborne contaminants through the building, less likelihood of drafts and noise due to lower volumes of air movement, and reduced space requirements for the ventilation system. Thermal comfort will be enhanced because the radiant temperature of large ceiling areas will be low (Feustel 1993).

Decreasing Friction Losses in Closed-Loop Water Systems

The pumping energy required for hydronic space conditioning systems and other systems for circulating fluids is dependent on the amount of friction in the pipes and components (e.g., heat exchangers and pumps). A new frontier for saving energy in closed-loop systems in buildings involves adding surfactants to the circulating fluid to reduce friction losses. Recent research results suggest a great potential for energy savings and for non-energy benefits (Gasljevic, K., et al, 1991 ~ Gasljevic and Matthys 1992; personal communication: Eric Matthys, U.S. Santa Barbara). Friction reductions of 60 to 80% have already been demonstrated. Experiments have shown less cavitation (small bubbles formed by local boiling, that collapse noisily), especially in pumps. In addition to creating noise, cavitation is also destructive to pumps and other hardware. Decreased friction leads to less vibration in pipe networks and a lower power requirement for pumping, possibly prolonging pump life (e.g., if pumps are used with variable-speed drives to enable speed control). Alternatively, because many existing hydronic systems are under designed, the addition of surfactants can increase the capacity of performance of an existing system. Since the greatest electricity savings will tend to occur during peak conditions, it is reasonable to expect that friction reductions will lead to reduced equipment failure and wear and tear on hydronic systems. Surfactants may also decrease corrosion rates in pipes.

Appendix E
ONGOING CO₂ REDUCTION PROJECTS

This appendix includes descriptions of the following existing efforts to reduce CO₂ emissions in Chula Vista (based on project summaries provided by the City of Chula Vista):

City

- Smogbuster electric and CNG vehicle rebates
- Telecenters
- Aluminum air fuel cell R&D
- Hydrogen fuel cell bus demonstration
- Vanpool
- Municipal building retrofit program
- Education Program

SDG&E

- Alternative fueled vehicle

SMOGBUSTERS ALTERNATIVE FUEL VEHICLE REBATE PROJECT

Local businesses can get up to \$4,000 from the City of Chula Vista to convert their cars and trucks to run on electric or to buy electric powered vehicles in a groundbreaking program, and can test drive and experience first-hand the benefits of an electric vehicle as part of the smogbuster vehicle rebate project.

The project provides local businesses with a rebate of up to \$4,000 toward an approved electric or natural gas vehicle retrofit. Businesses that have fleet vehicles which use predesignated short routes are the prime candidates for the city's rebate program. Retail vehicles are a perfect example. The city encourages businesses to take advantage of this one-time rebate offer to help prepare for requirements of the U.S. Energy Policy Act, which requires businesses with a fleet of more than 20 vehicles to phase in alternative fuel vehicles beginning in 1999.

Businesses may also qualify for federal and state tax incentives of up to \$5,000 in income tax credits for an electric vehicle retrofit. The Smogbusters Program is funded by the California Energy Commission.

TELECENTERS PROJECT

In April 1994, the City Council approved the development of two Telecenters, funded through various grants. The first telecenter opened in August 1994, the second in December 1994. Since the first telecenter opened at East "H" Street, the City has been part of a state-wide study on the impact telecenters have on trip reduction. The primary goal of establishing a telecenter program is to enable residents to work out of the telecenter one to four days per week. The telecenters serve the city's highest concentration of "information workers" - those residents who can work at their current job at a site closer to home through the use of telecommunications equipment (i.e. computers, modems, and telephones) to stay in touch with their office. A secondary goal is to develop partnerships that will assist in the goal of reducing or eliminating vehicle trips by using the telecenters for a variety of purposes, such as distance learning, telemedicine, and videoconferencing. Finally the Telecenters provide economic development opportunities by retaining residents in the community -- capturing shopping, restaurant and retail dollars otherwise spent outside the City, reducing travel, and freeing up local infrastructure resource demands.

Currently, the City's telecenters are used statewide as a model for the development of telecenters. The East "H" Street telecenter has an occupancy rate of 42% and the downtown telecenter, open only 6 months, has an occupancy rate of 42%, a full time renter, and income generation of over \$2,000 per month. Regarding the renter, University of Phoenix has an ongoing agreement with the Telecenter; the University rents private office space and additionally holds regular evening classes in both the classroom and the conference room. Staff has produced a telecenter marketing and business plan, which outlines the following: the telecenters shall be operational for three years prior to becoming self-sufficient. After the third year, numerous partnerships should be developed which will bring a combination of grant funds and additional revenue to turn the telecenter into a profitable venture. As of June 1995, during its first year of operation, the telecenters have generated over \$10,000 in revenue, are projected to continue generating over \$2,000 per month. Total vehicle miles traveled (VMT) savings for 1995 are estimated at 140,140 VMT.

The Telecenter Task Force established milestones to measure the ongoing effectiveness and success of the telecenters. These include: increasing occupancy rate for the East "H" Street Telecenter to 75% by June 1996, and 50% by January 1996 for the downtown telecenter; increasing revenue to \$5,000 per month by the end of year two, establishing three major partnerships by the end of year two. At the end of the second year, staff will use these milestones to compare with occupancy rates and revenues. Based upon this information, staff will provide recommendations to the Council on the continuation of the telecenter project.

ALUMINUM AIR FUEL CELL R&D

Per direction by the City Council to promote environmental businesses, to "incubate" new environmental technologies with future promise for commercialization and growth, and to develop a comprehensive energy conservation program, staff has participated in the aluminum air fuel cell development project from its onset. The City has acted as catalyst in this project by passing through federal/state funds legislated for this purpose to SAIC, a local business, for the development of a pick-up truck powered with an aluminum fuel cell and the commercialization of portable power generators utilizing the technology developed during the first phase. In return, SAIC has stated its intent to locate a facility in either the BECA incubator and/or the Hi-Tech/Bio-Tech zone.

In November 1993, the City Council approved acceptance of \$50,000 in grant funding from the CEC, which was specifically legislated for the sole purpose of sponsoring an experimental aluminum air battery (fuel cell) research/development project.

The goal of the first phase has been to demonstrate, in the laboratory, the operation of a fuel cell using inexpensive aluminum pellets. Planned later phases include the construction of prototype power sources and their demonstration in products such as portable generators and the development of an electric pick-up truck powered with aluminum fuel cell technology. Later phases would also include marketing and mass production of products that have demonstrated a market in the prototype phase.

A fuel cell is an "electric engine" that, in this case, utilizes aluminum metal to power the fuel cell. Fuel cells offer the potential to replace internal combustion engines in transportation applications and have already been used as power sources in spacecraft and stationary power units. The aluminum air fuel cell generates electricity through the following method: inexpensive aluminum pellets are dropped into a storage hopper on-board the vehicle, the pellets are then fed into a container filled with a chemical, or electrolyte, which reacts electrochemically with the aluminum. This reaction produces electricity to power the vehicle. The by-product, which is a powder produced from this process, is filtered into a replaceable cartridge (similar to an ink cartridge in a copy machine) and can be removed when the aluminum is spent. This byproduct is benign and recyclable. Advantages of an aluminum air fuel cell includes:

- extended range compared to battery powered vehicles;
- emits no pollutants when consumed;
- displaces petroleum consumption - reduced dependence on one fuel source;
- has a high energy density;
- is nonflammable and nontoxic; and
- is abundant and recyclable

Aluminum is considered to be an attractive fuel due to the fact that aluminum is extremely energy-efficient, producing a large amount of energy per unit compared with other fuels. Aluminum is the third most abundant element in the earth, it can be supplied domestically, is nontoxic, nonflammable, recyclable and produces zero emissions.

The main disadvantage to using aluminum as a fuel is that it is expensive compared to fossil fuels or hydrogen. One of the primary goals of Phase I and Phase II of this development effort is to reduce this cost as much as possible by demonstrating the feasibility of using cheap, "smelter-grade" aluminum as a fuel. The Phase I project team and Phase II planning team members include the City of Chula Vista, SAIC, Eltech Research Corporation, Kaiser Aluminum, the South Coast Air Quality Management District, the California Energy Commission (which provided funding to the City) and Pennsylvania State University. This group represents the leading U.S. experts on aluminum/air power systems.

The next phase, will include:

- a. the manufacturing of portable power generators, initially developed for military field applications, and
- b. demonstration of a prototype electric pickup truck rechargeable in 10 minutes with a range of 300 miles.

The onboard energy source will be an aluminum air fuel cell based upon the findings of Phase I. The aluminum air powered truck produced during this phase will have a longer range, with a shorter recharge time, than any zero emission vehicle ever developed. The power system will be fueled in the same way as described in Phase I. Refueling will be possible in ten minutes or less, and the range of the vehicle will be at least 300 miles between refueling.

HYDROGEN FUEL CELL BUS DEMONSTRATION PROJECT

Objective

- To reduce new and existing mobile source emissions through the use of three zero emission hydrogen fuel cell buses.
- To pioneer the use of fuel cell buses in the San Diego region and propel the development of fuel cell technology within the context of the state's environmental technology development efforts.
- To further refine the database on the performance, cost, and reliability of zero emission hydrogen fuel cell buses.
- To contribute to the development of fuel cell propulsion and facilitate replacement of internal combustion engines as the primary mode of transportation.

Project Description

With assistance from state, federal and local funding sources, the City of Chula Vista intends to purchase three zero emission hydrogen fuel cell buses from a California business consortium including New Flyer Industries, Science Application International Corporation of San Diego and Ballard Power Systems - California office; operating each of them on high ridership routes for a combined total of 500,000 miles. This demonstration project will include a hydrogen fueling station, field support for Chula Vista Transit personnel, and coordination, analysis, and reporting on the performance, cost, and reliability of the five vehicles.

The City of Chula Vista's proposal utilizes:

- Proton exchange membrane (PEM) fuel cell technology as a promising alternative energy and ultra low emission technology
- The PEM concept is potentially the lowest cost of several fuel cell technologies being developed and the most practical fuel cell technology for vehicles.

- Strong project team members. Ballard is the leader in PEM technology. New Flyer Industries supplies mass transit systems in Atlanta, Boston, Chicago, Toronto and Vancouver. Potential emissions reduction benefits to advance State Implementation Plan goals.

The City of Chula Vista has one of the highest suburban riderships for mass transit in the region. MTDB operates the regional trolley system, the regional bus system, and regulates the taxi and jitney system for the San Diego region. The routes chosen to utilize each vehicle will combine both suburban and heavy urban duty service. The regional routes will provide visibility for the vehicles throughout the South Bay of San Diego.

The City also is home to the only year-round Olympic Training Center, of which tours will be conducted by bus on a regular basis. Other upcoming events of national significance are the Republican National Convention in 1996 and the Superbowl in 1998. The City would lend the hydrogen fuel cell buses for these highly visible events to generate interest and provide maximum exposure for this emerging technology.

The vehicles provide the same or better performance than a diesel equivalent and meets the requirement of a ZEV as required by the CARB. It also has direct defense conversion and job creation applicability, in that the hydrogen fuel cells were originally developed to be used by NASA as a reliable power source within the space shuttle program. Originally, the fuel cells were large and cumbersome, used in the early space shuttle missions. Since then, the PEM technology for hydrogen fuel cells have been reduced in size and refined to be operated within the context of a zero emission vehicle.

The three buses to be purchased are New Flyer H40LF Low Floor vehicles, fitted with Ballard 275 HP Fuel Cells in place of an internal combustion engine. Vehicle performance meets Federal Transit Administration criteria. Each will hold 60 passengers (39 seated, 21 standing), is fueled by compressed hydrogen gas, and has a range of 250 miles.

VAN POOL PROGRAM

The City of Chula Vista plans to purchase three new dedicated CNG shuttle vans to replace city pool cars. These vehicles would serve employees in highly populated areas of the city, not served by transit, who are commuting to worksites within the City. The vans would also serve the telecenters. Eventually, the City hopes to expand the vanpool program to include employees commuting to private companies within the City.

The City will develop a program that will concentrate on employees that commute 20 miles or more per trip. The APCD will reimburse the City upon approval and certification of city paid invoices for purchase of CNG vans.

Vanpoolers will maintain a daily log of trips, mileage and number of riders carried. The City will report that information to the APCD every six months for the first year and annually thereafter, for three years. The APCD will reimburse the City up to \$50,000 after receiving and verifying documentation the City has purchased three CNG vans for use in the Alternative Fuels Vanpool Program. The City will also keep track of the number of miles driven per week and will require the vanpoolers to log trips that have been eliminated due to the vanpool. The City will provide a bi-annual report indicating the number of vehicular trips that have been eliminated due to the vanpool program based upon weekly logs, for the first year, and annually thereafter for three years. The City anticipates that each van will hold up to 7 passengers. At maximum capacity, the City's vanpool program will eliminate 42 vehicular trips per day, 210 trips per week and 10,920 trips annually.

SDG&E ALTERNATIVE FUEL VEHICLE PROGRAM

To date, SDG&E has put into service more than 140 natural gas vehicles in its own fleet and continues to add more. In addition, it is working to make the operations of NGVs as convenient as possible for fleet owners. As of September 1995, there were 950 NGVs in operation in the SDG&E service area, with 13 public and 9 private CNG fueling stations to serve them. SDG&E has plans to maintain the infrastructure for EV charging for both its commercial/industrial and residential customers.

Appendix F
REDUCTION MEASURES SUITABLE FOR CHULA VISTA

This Appendix contains 70 CO₂ reduction measures found by the Task Force to be suitable for Chula Vista implementation in addition to the 20 action measures described in Appendix F.

Municipal Transportation Control

These are transportation control measures that can be directly implemented by municipal government.

Transit

- Route improvements
- Terminal/stop improvements

Parking management

- Parking cash-out
- HOV preferential parking
- Provide credit against required parking standards
- Improved enforcement
- Bus stop relocation to parking areas

Shopper shuttle

- Shopper shuttle service

Ridesharing

- Transportation management associations
- Vanpool programs
- Carpool matching programs
- Guaranteed ride home

Information distribution

- Ridesharing/park and ride signage
- Ridesharing matching programs
- Transit/paratransit promotion
- Traffic condition announcements/signs

Pedestrian travel

- Safety improvement
- Direct connections with transit

Bicycle travel

- Education and promotion
- Integration at employment/shopping areas
- Integration with transit

Roadway assignment

- Reversible-flow bus and car lanes

Non-Municipal Transportation Control

These are transportation control measures that require implementation by non-municipal organizations. In some cases, non-municipal measures are duplicative of municipal actions where both sectors can contribute simultaneously to transportation control.

Transit

- Commuter discounts
- Peak/off-peak transit fares

Parking management

- Parking cash-out
- Parking cost increases

Employment travel

- Four-day work week
- Employment benefits based on HOV/transit use
- Tax incentives for vanpool or transit

Student travel

- Parking/carpool incentives
- School mandated cost recovery
- Reduced minimum distance for bus riders

Pricing

- Merchant transportation incentives for shoppers
- Lower rates/preferential treatment for HOVs

Traffic control

- Reversible-flow bus and car lanes

Clean Transportation Fuels

These are clean transportation fuel measures available for public and private fleet operators, and the traveling public at large.

Vehicle fueling

- Comprehensive municipal departmental review and removal of any code barriers to clean fuels commercialization.

General

- Technical assistance and/or referral services for persons interested in conversion/purchase.
- Expansion of adult/local college job training aimed at maintenance of clean fuel vehicles and fueling infrastructure.
- Preferential treatment of clean fueled vehicles, such as parking privileges.

- Recruitment of designers and parts manufacturers supplying components to the clean fuel industry.
- Awards program to recognize exemplary clean fuel efforts in the community.
- Use of high visibility special applications to demonstrate commercially-available clean fuel vehicles to the community at large.
- Monitoring of emerging clean fuel technologies to take advantage of research and development or pilot demonstration opportunities.

Land-Use

These are land-use policies that can be incorporated into the general plan, specific plans, the zoning and subdivision ordinances, and site design review criteria.

Use mix

- Increasing mix of residential types
- Decentralized services at dispersed location

Housing density

- Encouraging infill housing

Employment density

- Increasing employment density near shopping
- Increasing employment infill with focused economic development incentives

Site design

- Traditional neighborhood design orientation
- Solar orientation for commercial development
- Vegetative cooling and carbon-absorbing landscaping

Mobility

- Multimodal, highly-interconnected street networks
- Revise minimum/appropriate parking requirements

Building Efficiency

These are efficient building design and construction programs that can be implemented by the municipality and other stakeholders.

Voluntary residential programs

- Home efficiency rating system
- Demonstration projects
- Municipal design review criteria
- Expedited permit reviews and bonuses

Voluntary nonresidential programs

- Business efficiency rating system
- Demonstration projects
- Municipal design review criteria
- Expedited permit reviews and bonuses

Municipal Government

These are measures that apply to municipal government operations and housekeeping, as well as overall energy efficiency program administration.

Municipal management

- Comprehensive energy accounting
- Energy efficiency program administration

Municipal transportation

- High-efficiency conventional fuel vehicle purchase
- Maintenance and driving technique improvements

Municipal infrastructure

- Street light upgrades
- Large pump and motor upgrades

Appendix G

REDUCTION MEASURE DEFINITIONS & CO₂ SAVINGS ESTIMATES

This Appendix contains 168 generic CO₂ reduction measures provided by the consultant and reviewed found by the Task Force for suitability to Chula Vista. The Task Force eliminated 78 measures as not suitable. The remaining 90 measures met suitability criteria. Because the scope of the Chula Vista CO₂ Project provided consultant and financial resources for further study of only 20 "top measures", the Task Force was asked to refine the list to 20 action measures for initial implementation. The 70 remaining preferred measures are eligible for future consideration. The first half of this Appendix contains measure definitions, and the second half contains estimates of the measures' CO₂ savings potential in 2010.

1. TRANSPORTATION

1.1 Transportation Control Measures

1. **Commuter travel reduction program**

The commuter travel reduction program includes following program elements: a) employment trip reduction program; b) ride sharing program; c) parking management program; d) telecommuting; e) compressed work week; f) employer transit subsidy; g) flexible work hours; and h) staggered work hours. The assumed implementation is Level 2 consistent with SANDAG's TCM plan.

2. **College travel reduction program**

This measure has two components a travel reduction plan and a student transit pass subsidy. The assumed implementation is Level 1 consistent with SANDAG's TCM plan.

3. **Non-commuter travel reduction program**

This program encompasses the following actions: a) avoiding "cold starts;" b) in 2-car households, using the less polluting auto more frequently; c) driving during off-peak hours; and d) driving only when necessary on days with high pollution Levels. The assumed implementation is Level 1a consistent with SANDAG's TCM plan.

4. **Transit improvements and expansion**

This measure consists of conversion of the current bus fleet to low emission vehicles, the expansion of bus services using low emission vehicles and expansion of trolley services. The assumed implementation is Level 1 consistent with SANDAG's TCM plan.

5. **Vanpool program**

This measure provides 7-15 passenger vehicles to employers for use by employees in a ride share program. The assumed implementation is Level 1 consistent with SANDAG's TCM plan.

6. **High occupancy vehicle (HOV) lanes**

HOV facilities are vehicle travel lanes reserved for the exclusive use of buses or carpools. The assumed implementation is Level 1 consistent with SANDAG's TCM plan.

7. **Park and ride facilities**

Park and ride facilities are automobile parking lots for the use of commuters and other motorists. The assumed implementation is Level 1 consistent with SANDAG's TCM plan.

8. **Bicycle facilities**

Expansion of bicycling include the construction of bikeways, secure parking and storage facilities, bike racks or space on transit and locker and shower facilities for cyclists. The assumed implementation is Level 1 consistent with SANDAG's TCM plan.

9. **Pedestrian facilities**

Provide better pedestrian facilities. The assumed implementation is Level 1 consistent with SANDAG's TCM plan.

1.2 **Clean Fuel Conversion/Purchase**

10. **Compressed natural gas (CNG) vehicles**

Convert existing vehicles to CNG and buy CNG vehicles.

11. **Electric vehicles**

Buy electric vehicles.

12. **Other Alternative Fuel Vehicles**

Convert or purchase hydrogen vehicles

1.3 **High Efficiency Vehicle Purchase**

13. **Fuel efficient gasoline/diesel vehicles**

Buy and use fuel efficient gasoline and diesel vehicles that have the highest CAFE ratings.

1.4 **Maintenance Improvements**

14. **Increased maintenance**

Achieve better fuel efficiency through increased maintenance.

2. **LAND USE**

2.1 **Use Mix**

15. **Increasing multi-family residential mix**

Increasing the ratio of multi-family dwellings to single-family dwellings.

16. **Increasing mix of residential and complementary uses**

Increasing the ratio of residential uses to complementary nonresidential uses such as shopping, day care, and entertainment.

2.2 Housing Orientation

17. Solar Orientation

Land development design that orients land parcels for solar use.

2.3 Housing Density

18. Increasing housing density near transit

Increasing housing density near transit services and facilities.

19. Increasing housing density near employment

Increasing housing density near employment centers.

20. Increasing housing density near shopping

Increasing housing density near major shopping districts.

2.4 Employment Density

21. Increasing employment density near transit

Increasing employment density near transit services and facilities.

22. Increasing employment density near shopping

Increasing employment density near major shopping districts.

2.5 Circulation Coordination

23. Pedestrian oriented design

Increased pedestrian orientation of uses.

24. Integrated street networks

High connectivity in street patterns and intermodal linkages.

25. Appropriate parking facilities

Management of parking to minimize induced auto dependence.

3. RESIDENTIAL

3.1 Residential - New Construction

3.1.1 Space heating

26. Solar orientation

Orienting the house for passive solar design and active solar use.

27. No electric heating

Electric heating prohibition shifts heating load to less carbon intensive natural gas.

28. Pulse technology gas furnace.

A gas fired furnace operating at 92% efficiency.

3.1.2 Space cooling

- 29. **Heat pump with a seasonal energy efficiency ratio (SEER) 12 rating**
Split system efficient heat pumps with a heating seasonal performance factor (HSPF) of 8.0 and SEER of 12.0 versus units rated at 6.8 HSPF and 9.9 SEER (the base numbers are from 1992 residential energy standards) are assumed for this measure.
- 30. **Vegetative cooling**
Shade trees on south and west side of homes.
- 31. **Light colored roof**
The color and material of a building structure determine the amount of solar radiation absorbed. A roof absorptivity of 0.3 versus a baseline assumption of 0.8 is assumed for this measure.
- 32. **Light roof and wall**
The color and material of a building structure determine the amount of solar radiation absorbed. A roof and wall absorptivity of 0.3 versus a baseline assumption of 0.8 is assumed for this measure.
- 33. **Indirect/direct evaporative cooling (IDEC)**
IDEC systems precool outdoor air without adding moisture before the direct stage using an evaporative heat exchanger.
- 34. **High efficiency ceiling fans**
Increasing convective heat transfer coefficient allows increasing cooling setpoint temperature while still maintaining comfort. Energy impacts are measured by allowing the cooling setpoint to increase by 2° F.

3.1.3 Domestic Hot Water (DHW)

- 35. **Pilotless Instant DHW**
Standby costs of gas water heater is typically 30-50% of total water heater gas use (Davis Energy Group 1991). A pilotless instant DHW cuts this loss.
- 36. **Solar assisted DHW**
Using active solar panels with storage tanks with electric heater as backup.

3.1.4 Appliances

- 37. **Induction stovetop**
This measure saves energy through the use of electromagnetic technology. The induction stovetop uses a high frequency, electronically controlled electromagnet to produce heat in ferromagnetic cookware. Energy is saved because of the reduction in radiant heat losses.
- 38. **Golden carrot refrigerator**
Golden carrot refrigerators incorporate improved compressors, heat exchange cycles, heat exchangers, gaskets, refrigerants, defrost cycles, and insulation.
- 39. **Advanced freezer**
Advanced freezers have higher insulation levels and high efficiency compressors.

- 40. **Low water and energy use dishwasher**
Dishwashers consuming 1.5 KWH/cycle as opposed to 2.17 KWH/cycle.
- 41. **Horizontal axis clothes washer**
Horizontal axis clothes washer uses less detergent, less water, less energy, and has less moving parts.
- 42. **Heat pump clothes dryer**
Heat pump clothes dryer extracts low grade heat from the air, upgrades it and then is injected into the clothes dryer.

3.1.5 Pools and spas

- 43. **Solar assisted spa water heating**
Using active solar panels to heat spa water with electric heaters as backup.
- 44. **Solar assisted pool water heating**
Using active solar panels to heat pool water with electric heaters as backup.
- 45. **Premium efficiency spa pump**
Two speed spa pump consists of a small motor that can run at two speeds. During low usage the spa pump can be run at low speed.
- 46. **Premium efficiency pool pump**
Two speed pool pump consists of a small motor that can run at two speeds. During low usage the pool pump can be run at low speed.

3.1.6 Lighting

- 47. **Fluorescent halogen 0.8 kW**
Using T8 or energy saver fluorescent lamps instead of standard fluorescent lamps.

3.2 Residential-Retrofit

3.2.1 Space heating

- 48. **No electric heating**
Electric heating prohibition shifts heating load to less carbon intensive natural gas.
- 49. **Pulse technology gas furnace.**
A gas fired furnace operating at 92% efficiency
- 50. **Wall insulation**
Residential wall insulation is increased from R-0 to R-11.
- 51. **Ceiling insulation**
Ceiling insulation is increased from R-11 to R-19.
- 52. **Double pane windows**
Using double pane windows in place of single pane windows.

3.2.2 Space cooling

53. Heat pump with a seasonal energy efficiency ratio (SEER) 12 rating

Split system efficient heat pumps with a HSPF of 8.0 and SEER of 12.0 versus units rated at 6.8 HSPF and 9.9 SEER (the base numbers are from 1992 residential energy standards) are assumed for this measure.

54. Vegetative cooling

Shade trees on south and west side of homes.

55. Light roof

The color and material of a building structure determine the amount of solar radiation absorbed. A roof absorptivity of 0.3 versus a baseline assumption of 0.8 is assumed for this measure.

56. Light roof and wall

The color and material of a building structure determines the amount of solar radiation absorbed. A roof and wall absorptivity of 0.3 versus a baseline assumption of 0.8 is assumed for this measure.

57. Indirect / direct evaporative coolers (IDEC)

IDEC systems precool outdoor air without adding moisture before the direct stage using an evaporative heat exchanger.

58. High efficiency ceiling fans

Increasing convective heat transfer coefficient allows increasing cooling setpoint temperature while still maintaining comfort. Energy impacts are measured by allowing the setpoint to increase by 2°F.

3.2.3 DHW

59. Pilotless instant DHW

Standby costs of gas water heater is typically 30-50% of total water heater gas use (Davis Energy Group 1991). A pilotless instant DHW cuts this loss.

60. Solar assisted DHW

Using active solar panels with storage tanks with electric heater as backup.

3.2.4 Appliances

61. Induction stovetop

This measure saves energy through the use of electromagnetic technology. The induction stovetop uses a high frequency, electronically controlled electromagnet to produce heat in ferromagnetic cookware. Energy is saved because of the reduction in radiant heat losses.

62. Golden carrot refrigerator

Golden carrot refrigerators incorporate improved compressors, heat exchange cycles, heat exchangers, gaskets, refrigerants, defrost cycles, and insulation.

63. Advanced freezer

Advanced freezers have higher insulation levels and high efficiency compressors.

- 64. **Low water and energy use dishwasher**
Dishwashers consuming 1.5 KWH/cycle as opposed to 2.17 KWH/cycle and reduce water consumption by 20%.
- 65. **Horizontal axis clothes washer**
Horizontal axis clothes washer uses less detergent, less water, less energy, and has less moving parts.
- 66. **Heat pump clothes dryer**
Heat pump clothes dryer extracts low grade heat from the air, upgrades it, and then is injected into the clothes.

3.2.5 Pools and spas

- 67. **Solar assisted spa water heating**
Using active solar panels to heat spa water with electric heaters as backup.
- 68. **Solar assisted pool water heating**
Using active solar panels to heat pool water with electric heaters as backup.
- 69. **Premium efficiency spa pump**
Two speed spa pump consists of a small motor that can run at two speeds. During low usage the spa pump can be run at low speed.
- 70. **Premium efficiency pool pump**
Two speed pool pump consists of a small motor that can run at two speeds. During low usage the pool pump can be run at low speed.

3.2.6 Lighting

- 71. **Fluorescent halogen 0.8 kW**
Using T8 or energy saver fluorescent lamps could be used instead of standard fluorescent lamps.

4. COMMERCIAL

4.1 Small Office-New Construction

4.1.1 Heating and cooling system

- 72. **District heating and cooling**
District heating and cooling is delivery of thermal energy to a high demand geographic area through a common source.

4.1.2 Space cooling

- 73. **Economizer maintenance**
Economizer maintenance consists of adjusting actuators, lubricating dampers, calibrating controls, and other maintenance checks as required to keep outside air economizer systems working properly.
- 74. **Clean condenser coils**
Air cooled condenser coils on air conditioning systems may become dirty or fouled over time from exposure to outdoor contaminants. Cleaning the condenser coils helps to maximize the air conditioning systems efficiency.
- 75. **High efficiency direct expansion (DX) AC-coefficient of performance (COP) 3.2**
Increasing COP of DX units from 2.9 to 3.2.
- 76. **New glazing high performance tint**
A window with a shading coefficient of 0.81 and U-value of .48 is changed to a window with a shading coefficient of 0.15 and U-value of 0.41.
- 77. **Light colored roofs**
The color and material of the building structure will determine the amount of solar radiation absorbed by that surface. The baseline absorptance is assumed to be 0.8 (based on survey data and engineering judgment) while the light colored roof is assumed to have an absorptance of 0.3.

4.1.3 Lighting

- 78. **Indoor lighting medium reduction**
This measure consists of a combination of measures which includes compact fluorescents, energy saver fluorescent lamps, T-8 fluorescent lamps, electronic ballasts, optical reflectors and metal halide lamps.
- 79. **Occupancy sensor pack-200**
An occupancy sensor detects motion using changes in ultrasonic or infrared waves. After detecting an occupant it switches on lights for a predetermined period of time.

4.1.4 Office equipment

- 80. **High efficiency office copiers**
This measure involves using copiers that shut off in stages when not in use.
- 81. **Energy star rated computers**
Energy star computers go to sleep when not in use. This could save up to 75% of their energy consumption.

4.2 Small Office-Retrofit

4.2.1 Space cooling

- 82. **Economizer maintenance**
Economizer maintenance consists of adjusting actuators, lubricating dampers, calibrating controls, and other maintenance checks as required to keep outside air economizer systems working properly.

83. Clean condenser coils

Air cooled condenser coils on air conditioning systems may become dirty or fouled over time from exposure to outdoor contaminants. Cleaning the condenser coils helps to maximize the air conditioning systems efficiency.

84. High efficiency DX AC-COP 3.2

Increasing COP of DX units from 2.9 to 3.2.

85. New glazing high performance tint

A window with a shading coefficient of 0.81 and U-value of .48 is changed to a window with a shading coefficient of 0.15 and U-value of 0.41.

86. Time clocks

A timeclock for heating and cooling shuts off the supply fans during programmed unoccupied periods.

87. Light colored roofs

The color and material of the building structure will determine the amount of solar radiation absorbed by that surface. The baseline absorptance is assumed to be 0.8 (based on survey data and engineering judgment) while the light colored roof is assumed to have an absorptance of 0.3.

88. Deadband thermostat

A deadband thermostat prevents both the heating and cooling systems from operating simultaneously, in immediate succession, or when room characteristics require no conditioning of air.

4.2.2 Lighting

89. Indoor lighting low load reduction

This measure is a combination of measures which include compact fluorescents, energy saver fluorescent lamps, T-8 fluorescent lamps, electronic ballasts, optical reflectors, and metal halide lamps.

90. Occupancy sensor pack-200

An occupancy sensor detects motion using changes in ultrasonic or infrared waves. After detecting an occupant it switches on lights for a predetermined period of time.

4.2.3 Office equipment

91. High efficiency office copiers

This measure involves copiers that shut off in stages when not in use.

92. Energy star rated computers

Energy star computers go to sleep when not in use. This could save up to 75% of their energy consumption.

4.3 Large office-New Construction

4.3.1 Heating and cooling system

93. District heating and cooling

District heating and cooling is delivery of thermal energy to a high demand geographic area through a common source.

4.3.2 Space cooling

94. High efficiency centrifugal chiller

A high efficiency centrifugal chiller capable of giving .70kW/ton is used as compared to a baseline of .75kW/ton.

95. Variable speed drive (VSD) centrifugal chiller

Motor speed can be adjusted by a VSD controller on a centrifugal chiller. The VSDs are used in addition to traditional inlet vanes used for capacity control. VSDs can be used for capacity control over a fairly small band near full load but inlet vanes would take over at low load.

96. Chiller strainer cycle

A chiller strainer cycle is a piping arrangement that allows evaporatively cooled water from the cooling tower to be used in place of mechanically chilled water during cold weather.

97. Economizer maintenance

Economizer maintenance consists of adjusting actuators, lubricating dampers, calibrating controls, and other maintenance checks as required to keep outside air economizer systems working properly

98. Cooling tower propeller fans

Using propeller fans in place of centrifugal blowers for a cooling tower could cut the fan consumption by 50% for the same performance.

99. Oversize coils

Oversizing the coils would allow face velocities to drop from 400 to 500 fpm range to 200 to 400 fpm range. This would also mean increasing sizes of other associated equipment.

4.3.3 Lighting

100. Indoor lighting medium reduction

This measure consists of a combination of measures which includes compact fluorescents, energy saver fluorescent lamps, T-8 fluorescent lamps, electronic ballasts, optical reflectors, and metal halide lamps.

101. Occupancy sensor pack-1000

An occupancy sensor detects motion using changes in ultrasonic or infrared waves. After detecting an occupant it switches on lights for a predetermined period of time.

4.3.4 Office equipment

102. High efficiency office copiers

This measure involves using copiers that shut off in stages when not in use.

103. Energy star rated computers

Energy star computers go to sleep when not in use. This could save up to 75% of their energy consumption.

4.4 Large Office-Retrofit

4.4.1 Space cooling

104. High efficiency centrifugal chiller

A high efficiency centrifugal chiller capable of giving .70kW/ton is used as compared to a baseline of .75kW/ton.

105. VSD centrifugal chiller

Motor speed can be adjusted by a variable speed drive controller on a centrifugal chiller. The variable speed drives are used in addition to traditional inlet vanes used for capacity control. VSD's can be used for capacity control over a fairly small band near full load but inlet vanes would take over at low load.

106. Chiller strainer cycle

A chiller strainer cycle is a piping arrangement that allows evaporatively cooled water from the cooling tower to be used in place of mechanically chilled water during cold weather.

107. Economizer maintenance

Economizer maintenance consists of adjusting actuators, lubricating dampers, calibrating controls, and other maintenance checks as required to keep outside air economizer systems working properly

108. Cooling tower propeller fans

Using propeller fans in place of centrifugal blowers for a cooling tower could cut the fan consumption by 50% for the same performance.

109. Oversize coils

Oversizing the coils would allow face velocities to drop from 400 to 500 range fpm to 200 to 400 fpm range. This would also mean increasing sizes of other associated equipment.

4.4.2 Lighting

110. Indoor lighting low reduction

This measure is a combination of measures which include compact fluorescents, energy saver fluorescent lamps, T-8 fluorescent lamps, electronic ballasts, optical reflectors and metal halide lamps.

111. Occupancy sensor pack-1000

An occupancy sensor detects motion using changes in ultrasonic or infrared waves. After detecting an occupant it switches on lights for a predetermined period of time

4.4.3 Office equipment

112. High efficiency office copiers

This measure involves using copiers that shut off in stages when not in use.

113. Energy star rated computers

Energy star computers go to sleep when not in use. This could save up to 75% of their energy consumption.

4.5 Retail-New Construction

4.5.1 Heating and cooling system

114. District heating and cooling

District heating and cooling is delivery of thermal energy to a high demand geographic area through a common source.

4.5.2 Space cooling

115. Economizer maintenance

Economizer maintenance consists of adjusting actuators, lubricating dampers, calibrating controls, and other maintenance checks as required to keep outside air economizer systems working properly.

116. Clean condenser coils

Air cooled condenser coils on air conditioning systems may become dirty or fouled over time from exposure to outdoor contaminants. Cleaning the condenser coils helps to maximize the air conditioning systems efficiency.

117. High efficiency DX AC-COP 3.2

Increasing COP of DX units from 2.9 to 3.2.

118. New glazing high performance tint

A window with a shading coefficient of 0.81 and U-value of .48 is changed to a window with a shading coefficient of 0.15 and U-value of 0.41.

119. Light colored roofs

The color and material of the building structure will determine the amount of solar radiation absorbed by that surface. The baseline absorptance is assumed to be 0.8 (based on survey data and engineering judgment) while the light colored roof is assumed to have an absorptance of 0.3.

120. Deadband thermostat

A deadband thermostat prevents both the heating and cooling systems from operating simultaneously, in immediate succession, or when room characteristics require no conditioning of air.

121. Shade screens

Shade screens attached to the exterior frame of the window to reduce the solar gain into the building spaces.

122. Reducing over-ventilation

Reducing overventilation can be accomplished with a CO₂ ventilation controller that can measure and display levels of CO₂ and automatically control existing ventilation systems.

4.5.3 Lighting

123. Indoor lighting medium load

This measure consists of a combination of measures which includes compact fluorescents, energy saver fluorescent lamps, T-8 fluorescent lamps, electronic ballasts, optical reflectors, and metal halide lamps.

4.6 Retail-Retrofit

4.6.1 Space cooling

124. Economizer maintenance

Economizer maintenance consists of adjusting actuators, lubricating dampers, calibrating controls, and other maintenance checks as required to keep outside air economizer systems working properly.

125. Clean condenser coils

Air cooled condenser coils on air conditioning systems may become dirty or fouled over time from exposure to outdoor contaminants. Cleaning the condenser coils helps to maximize the air conditioning systems efficiency.

126. High efficiency DX AC-COP 3.2

Increasing COP of DX units from 2.9 to 3.2.

127. New glazing high performance tint

A window with a shading coefficient of 0.81 and U-value of .48 is changed to a window with a shading coefficient of 0.15 and U-value of 0.41.

128. Economizer install-packaged

Retrofitting an economizer to a packaged system.

129. Light colored roofs

The color and material of the building structure will determine the amount of solar radiation absorbed by that surface. The baseline absorptance is assumed to be 0.8 (based on survey data and engineering judgment) while the light colored roof is assumed to have an absorptance of 0.3.

130. Time clocks

A timeclock for heating and cooling shuts off the supply fans during programmed unoccupied periods.

131. Deadband thermostat

A deadband thermostat prevents both the heating and cooling systems from operating simultaneously, in immediate succession, or when room characteristics require no conditioning of air.

132. Shade screens

Shade screens attached to the exterior frame of the window provide an excellent means of reducing the solar gain into the building spaces.

133. Reducing overventilation

Reducing overventilation can be accomplished with a CO₂ ventilation controller that can measure and display levels of CO₂ and automatically control existing ventilation systems.

4.6.2 Lighting

134. Indoor lighting low load reduction

This measure is a combination of measures which include compact fluorescents, energy saver fluorescent lamps, T-8 fluorescent lamps, electronic ballasts, optical reflectors and metal halide lamps.

5. INDUSTRIAL

5.1 Lighting

135. Lighting load low reduction case

This measure is a combination of measures which include compact fluorescents, energy saver fluorescent lamps, T-8 fluorescent lamps, electronic ballasts, optical reflectors, and metal halide lamps.

5.2 Ventilation

136. Reducing over-ventilation

Reducing overventilation can be accomplished with a CO₂ ventilation controller that can measure and display levels of CO₂ and automatically control existing ventilation systems.

5.3 Motors

137. VSD on Industrial Motors

Using variable speed drives on industrial motors.

6. MUNICIPAL OPERATIONS

138. Energy accounting

Establishment of a comprehensive energy tracking system for all municipal energy consumption, costs and savings (such as ENACT software).

6.1 Transportation

6.1.1 Municipal employee commute measures

139. Flexible work schedule

Staggered employee work hours.

140. Telecommuting

Telecommuting involves allowing employees to work from homes and setting up satellite offices.

141. Bicycle facilities

Increased employee bike facilities such as preferred parking, showers, and locked storage.

142. Carpooling

Employee carpooling incentives.

143. Transit Use

Employee transit incentives

6.1.2 Clean fuel conversion/purchase

144. CNG vehicles

Convert existing fleet to run on CNG rather than gasoline. Also purchase new vehicles that run on CNG.

145. Electric vehicles

Purchase new vehicles that use electricity rather than gasoline.

146. Other Alternative Fuel Vehicles

Convert existing fleet to run on alternative fuels such as hydrogen. Also purchase new vehicles that run on alternative fuels.

6.1.3 High efficiency vehicle purchase

147. Fuel efficient gasoline/diesel vehicles

Purchase vehicles that meet or exceed existing CAFE standards.

6.1.4 Maintenance and driving improvements

148. Regular maintenance

Regular maintenance can help save energy and also repair costs. A well tuned vehicle would burn less fuel than one that is not.

149. Driver efficiency training

Employee training on efficiency oriented driving technologies.

6.2 Municipal Buildings

6.2.1 Space cooling

150. High efficiency centrifugal chiller

A high efficiency centrifugal chiller capable of giving .70kW/ton is used as compared to a baseline of .75kW/ton.

151. VSD centrifugal chiller

Motor speed can be adjusted by a VSD controller on a centrifugal chiller. The VSD are used in addition to traditional inlet vanes used for capacity control. VSD's can be used for capacity control over a fairly small band near full load but inlet vanes would take over at low load ends.

152. Chiller strainer cycle

A chiller strainer cycle is a piping arrangement that allows evaporatively cooled water from the cooling tower to be used in place of mechanically chilled water during cold weather.

153. Economizer maintenance

Economizer maintenance consists of adjusting actuators, lubricating dampers, calibrating controls, and other maintenance checks as required to keep outside air economizer systems working properly

154. Cooling tower propeller fans

Using propeller fans in place of centrifugal blowers for a cooling tower could cut the fan consumption by 50% for the same performance.

155. Oversize coils

Oversizing the coils would allow face velocities to drop from 400 to 500 range fpm to 200 to 400 fpm range. This would also mean increasing sizes of other associated equipment.

6.2.2 Lighting

156. Indoor lighting medium reduction

This measure consists of a combination of measures which includes compact fluorescents, energy saver fluorescent lamps, T-8 fluorescent lamps, electronic ballast, optical reflectors, and metal halide lamps.

157. Occupancy sensor pack-1000

An occupancy sensor detects motion using changes in ultrasonic or infrared waves. After detecting an occupant it switches on lights for a predetermined period of time.

6.2.3 Office equipment

158. High efficiency office copiers

This measure involves using copiers that shut off in stages when not in use.

159. Energy star rated computers

Energy star computers go to sleep when not in use.

6.3 Municipal Services

6.3.1 Pumping

160. High efficiency pumps

Increasing pump and motor efficiencies.

161. Reduce demand charges

Reducing demand charges(i.e. low load factors) This could involve construction of additional storage facilities.

162. Reduce pumping requirements

Implement water conservation measures and technologies to reduce water consumption.

163. Variable speed drives

Using variable speed drives on pump motors.

6.3.2 Street lights

164. Solar assisted street lighting

Photovoltaic powered street lights.

165. High efficiency street lights

High efficiency street lights like sodium vapor or other more efficient luminaries

6.3.3 Traffic signals

166. High efficiency traffic signals and restricted use

Installing high efficiency traffic signals and operating the traffic signals only during peak traffic hours of the day.

167. Signal synchronization

Increased traffic flow efficiency with greater synchronization.

6.3.4 Forestation

168. Urban Forestation

Tree planting on public lands and other land voluntarily made available.

NOTE

The following spreadsheets contain implementation and savings estimates for each of the measures. Transportation control measures are analyzed using cost and savings estimates from SANDAG's regional transportation control plan. Clean fuel measures are analyzed using cost and savings estimates from the CEC's Transportation Energy Analysis Report. All other measures are analyzed using cost and savings estimates from the CEC's Database for Energy Efficient Resources (DEER). Where applicable, a simple payback has been calculated for the number of years it will take to recover a measure's implementation cost from annual energy cost savings. For example, a measure with a \$10,000 implementation cost and annual energy cost savings of \$1,000 would have a simple payback of 10 years.

Sector: Transportation
Sub Sector: Transportation Control Measures
Fuel: All Transportation Fuels

Measure	Implementation Cost (\$/VMT Saved)	SANDAG Implementation Level	Energy Savings (2010 MMBtu)	Cost/Benefit Ratio	CO ₂ Savings/Yr (2010 Tons)
Base case					
TCM 1: Commuter travel reduction program	0.06	2	728,496	0.37	55,269
TCM 2: College travel reduction program and ordinance	0.08	1	74,131	0.52	5,624
TCM 3: Non-commute travel reduction program	0.00	1a	1,393,843	0.00	105,747
TCM 4: Transit improvements and expansion	0.00	1	215,071	0.02	16,317
TCM 5: Vanpool program	0.20	1	22,880	8.98	1,736
TCM 6: High occupancy level lanes	0.15	1	38,438	2.17	2,916
TCM 7: Park and ride facilities	0.12	1	5,491	1.20	417
TCM 8: Bicycle facilities	0.13	1	8,237	1.44	625

Sector: Transportation
Sub Sector: Clean Fuel Conversion and Purchase
Fuel: All Transportation Fuels

Measure	Implementation Cost	Penetration Percentage	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
Base case	0	100.0%	0	0	0
CRM 1: Convert to CNG	622,071	0.5%	2,698	22	253
CRM 2: Convert to electric vehicle	1,104,582	0.5%	26,242	364	2,422
CRM 3: Convert to M85 vehicles	214,200	0.5%	1,102	16	84
CRM 4: Buy CNG vehicles	0	3.0%	16,189	0	1,516
CRM 5: Buy electric vehicles	0	2.9%	152,204	0	14,050
CRM 6: Buy M85 vehicles	0	7.8%	17,195	0	1,305
CRM 7: Fuel efficient gasoline and diesel vehicle	0	5.0%	338,177	0	25,656

Sector: Land Use
Sub Sector: N/A
Fuel: Transportation Fuels

Measure	Incremental Cost (\$)	VMT Savings (%)	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
Base case	0	N/A	N/A	N/A	N/A
CRM A: Infill	0	15	423,518	0	195
CRM B: Integrated streets	0	5	141,173	0	65
CRM C: Concentrated activity centers	0	10	282,346	0	130
CRM D: Transit oriented development	0	15	423,518	0	195
CRM E: Pedestrian oriented development	0	5	141,173	0	65
CRM F: Parking management	0	5	141,173	0	65

Sector: Residential
Sub Sector: Single-Family New Construction
Fuel: Electric

Measure	Incremental Cost (\$)	Penetration Rate (%)	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
End Use: Space Heating					
Base case	0	100%	0	0.00	0
CRM 1: Solar orientation	0	55%	836	0.00	152
CRM 2: Wall insulation R-11 to R-19	180	55%	1,569	6.76	286
CRM 3: Wood/vinyl windows	0	55%	4,908	0.00	893
End Use: Space Cooling					
Base case	0	100%	0	0.00	0
CRM 4: 12 SEER	530	55%	2,849	46.48	519
CRM 5: High efficiency ceiling fans	60	55%	7,430	2.02	1,352
CRM 6: Vegetative cooling	25	55%	6,363	0.95	1,158
CRM 7: Light roof	0	55%	665	0.00	121
CRM 8: Evaporative cooling	700	55%	9,255	18.90	1,685
End Use: Domestic Hot Water					
Base case	0	20%	0	0.00	0
CRM 9: A/C to DHW de-superheater	865	11%	961	44.97	175
CRM 10: Solar assisted DHW	727	11%	11,713	3.05	2,132
End Use: Lighting					
Base case	0	100%	0	0.00	0
CRM 11: Integral compact fluorescents	30	55%	5,018	1.49	913
CRM 12: Modular, hard wired CFL	15	55%	1,649	2.23	306
CRM 13: T-8 lamps with electric ballasts	72	55%	4,295	4.19	782
CRM 14: Ultrasonic occupancy sensors	52	55%	1,403	9.26	255
End Use: Appliances					
Refrigerator	0	100%	0	0.00	0
CRM 11: Golden carrot refrigerator	100	55%	8,156	3.06	1,485
Freezer	0	25%	0	0.00	0
CRM 12: Advanced freezer	172	14%	1,750	5.27	319
Dishwasher	0	55%	0	0.00	0
CRM 13: Low water and energy use dishwashers	20	30%	2,084	0.61	379
Clothes washer	0	80%	0	0.00	0
CRM 14: Horizontal axis clothes washer	175	44%	9,533	3.67	1,735
Clothes dryer	0	55%	0	0.00	0
CRM 15: Heat pump clothes dryer	300	30%	8,622	4.78	1,569
Color television	0	100%	0	0.00	0
CRM 16: Low powered color television	7	55%	723	2.42	132

Sector: Residential
Sub Sector: Single-Family New Construction
Fuel: Natural Gas

Measure	Incremental Cost (\$)	Penetration Rate (%)	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
End Use: Space Heating					
Base case	0.0	100%	0	0.00	0
CRM 1: Wall insulation R-11 to R-19	230.0	55%	18,296	11.86	1,063
CRM 2: Wood/vinyl windows	0.0	55%	23,897	0.00	1,388
End Use: Domestic Hot Water					
Base case	0.0	100%	0	0.00	0
CRM 3: Efficient gas water heater	664.0	55%	29,363	21.33	1,705
CRM 4: DHW heat trap	4.2	55%	1,186	3.34	69
CRM 10: Solar assisted DHW	727.0	55%	29,363	23.35	1,705
End Use: Spa Pool					
Base case spa heating	0.0	8%	0	0.00	0
CRM 5: Solar assisted spa heating	727.0	4%	12,406	4.42	721
Base case pool heating	0.0	8%	0	0.00	0
CRM 5: Solar assisted pool heating	727.0	4%	12,406	4.42	721

Sector: Residential
Sub Sector: Multi-Family New Construction
Fuel: Electric

Measure	Incremental Cost (\$)	Penetration Rate (%)	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
End Use: Space Heating					
Base case	0.0	100%	0	0.00	0
CRM 1: Solar orientation	0.0	55%	6,027	0.00	1,097
CRM 2: Wall insulation R-11 to R-19	187.0	55%	1,358	21.09	247
CRM 3: Wood/vinyl windows	0.0	55%	455	0.00	83
End Use: Space Cooling					
Base case	0.0	100%	0	0.00	0
CRM 4: 12 SEER	530.0	55%	1,390	58.67	253
CRM 5: High efficiency ceiling fans	60.0	55%	1,721	5.34	313
CRM 5: Window heat pump	825.0	55%	2,356	53.64	429
CRM 6: Vegetative cooling	25.0	55%	3,900	0.94	710
CRM 7: Light roof	0.0	55%	154	0.00	28
CRM 8: Evaporative cooling	700.0	55%	5,672	18.90	1,033
End Use: Domestic Hot Water					
Base case	0.0	20%	0	0.00	0
CRM 9: A/C to DHW de-superheater	865.0	11%	589	32.50	107
CRM 10: Hot water saver	250.0	11%	378	20.28	69
CRM 10: DHW heat trap	4.2	11%	180	0.16	33
CRM 10: Solar assisted DHW	727.0	11%	7,179	27.31	1,307
End Use: Lighting					
Base case	0.0	100%	0	0.00	0
CRM 11: Integral compact fluorescents	30.0	55%	2,085	2.20	379
CRM 12: Modular, hard wired CFL	15.0	55%	1,024	2.24	186
CRM 13: T-8 lamps with electric ballasts	72.0	55%	1,360	8.11	248
CRM 14: Ultrasonic occupancy sensors	52.0	55%	531	15.00	97
End Use: Appliances					
Refrigerator	0.0	100%	0	0.00	0
CRM 11: Golden carrot refrigerator	100.0	55%	4,999	3.06	910
Freezer	0.0	25%	0	0.00	0
CRM 12: Advanced freezer	172.0	14%	1,072	5.27	195
Dishwasher	0.0	55%	0	0.00	0
CRM 13: Low water and energy use dishwashers	20.0	30%	1,277	0.61	232
Clothes washer	0.0	80%	0	0.00	0
CRM 14: Horizontal axis clothes washer	175.0	44%	5,843	3.67	1,064
Clothes dryer	0.0	55%	0	0.00	0
CRM 15: Heat pump clothes dryer	300.0	30%	5,284	4.78	962
Color television	0.0	100%	0	0.00	0
CRM 16: Low powered color television	7.0	55%	443	2.42	81

Sector: Residential
Sub Sector: Multi-Family New Construction
Fuel: Natural Gas

Measure	Incremental Cost (\$)	Penetration Rate (%)	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
End Use: Space Heating					
Base case	0.0	100%	0	0.00	0
CRM 1: Combined hydronic space heater	1,425.0	55%	4,338	189.91	252
CRM 2: High efficiency gas furnace - pulse combustion	718.0	55%	1,275	325.70	74
CRM 2: Wood/vinyl windows	0.0	55%	14,647	0.00	851
CRM 3: Wall insulation R-11 to R-19	230.0	55%	11,213	11.86	651
End Use: Domestic Hot Water					
Base case	0.0	80%	0	0.00	0
CRM 3: Efficient gas water heater	664.0	44%	14,397	21.33	836
CRM 4: DHW heat trap	4.2	44%	582	3.34	34
CRM 10: Solar assisted DHW	727.0	44%	14,397	23.35	836
End Use: Spa Pool					
Base case spa heating	0.0	8%	0	0.00	0
CRM 5: Solar assisted spa heating	727.0	4%	7,406	4.42	442
Base case pool heating	0.0	8%	0	0.00	0
CRM 5: Solar assisted pool heating	727.0	4%	7,406	4.42	442

Sector: Residential
Sub Sector: Single-Family Retrofit
Fuel: Electric

Measure	Incremental Cost (\$)	Penetration Rate (%)	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
End Use: Space Heating					
Base case	0	100%	0	0.00	0
CRM 1: Wall insulation R-0 to R-11	680	55%	69,811	3.42	12,708
CRM 2: Duct insulation R-8	275	55%	3,537	27.28	644
CRM 3: Duct sealing	200	55%	11,010	6.38	2,004
CRM 4: Ceiling insulation R-11 to R-30	565	55%	5,422	36.59	987
CRM 5: Floor insulation R-11	764	55%	33,992	7.89	6,187
End Use: Space Cooling					
Base case	0	100%	0	0.00	0
CRM 6: 12 SEER	530	55%	5,418	34.33	986
CRM 7: Window heat pump	825	55%	81,303	3.56	14,800
CRM 8: Clock thermostats	169	55%	30,735	1.93	5,595
CRM 9: High efficiency ceiling fans	60	55%	16,204	0.30	2,950
CRM 10: Vegetative cooling	25	55%	8,934	0.13	1,626
CRM 11: Light roof	0	55%	934	0.00	170
CRM 12: Evaporative cooling	700	55%	28,428	3.52	5,175
End Use: Domestic Hot Water					
Base case	0	20%	0	0.00	0
CRM 13: DHW heat trap	4	11%	804	0.37	146
CRM 14: Hot water saver	250	11%	1,673	10.49	305
CRM 10: Solar assisted DHW	727	11%	16,448	3.65	2,994
End Use: Lighting					
Base case	0	100%	0	0.00	0
CRM 11: Integral compact fluorescents	30	55%	7,046	1.49	1,283
CRM 12: Modular, hard wired CFL	15	55%	2,357	2.23	429
CRM 13: T-8 lamps with electric ballasts	72	55%	6,031	4.19	1,098
CRM 14: Ultrasonic occupancy sensors	52	55%	1,970	9.36	359
End Use: Appliances					
Refrigerator	0	100%	0	0.00	0
CRM 11: Golden carrot refrigerator	100	55%	11,452	3.06	2,085
Freezer	0	25%	0	0.00	0
CRM 12: Advanced freezer	172	14%	2,457	5.27	447
Dishwasher	0	55%	0	0.00	0
CRM 13: Low water and energy use dishwashers	20	30%	2,926	0.61	533
Clothes washer	0	80%	0	0.00	0
CRM 14: Horizontal axis clothes washer	175	44%	13,385	3.67	2,437
Clothes dryer	0	55%	0	0.00	0
CRM 15: Heat pump clothes dryer	300	30%	12,106	4.78	2,204
Color television	0	100%	0	0.00	0
CRM 16: Low powered color television	7	55%	1,015	2.42	185

Sector: Residential
Sub Sector: Single-Family Retrofit
Fuel: Natural Gas

Measure	Incremental Cost (\$)	Penetration Rate (%)	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
End Use: Space Heating					
Base case	0	100%	0	0.00	0
CRM 1: Wall insulation R-11 to R-19	230	55%	25,690	11.86	1,492
CRM 2: Wood/vinyl windows	0	55%	33,555	0.00	1,949
End Use: Domestic Hot Water					
Base case	0	80%	0	0.00	0
CRM 3: Efficient gas water heater	664	44%	32,984	21.33	1,916
CRM 4: DHW heat trap	4	44%	1,333	3.34	77
CRM 10: Solar assisted DHW	727	44%	32,984	23.35	1,916
End Use: Spa Pool					
Base case spa heating	0	8%	0	0.00	0
CRM 5: Solar assisted spa heating	1,200	4%	17,420	7.30	1,012
Base case pool heating	0	8%	0	0.00	0
CRM 5: Solar assisted pool heating	1,200	4%	17,420	7.30	1,012

Sector: Residential
Sub Sector: Multi-Family Retrofit
Fuel: Electric

Measure	Incremental Cost (\$)	Penetration Rate (%)	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
End Use: Space Heating					
Base case	0.0	100%	0	0.00	0
CRM 1: Wall insulation R-11 to R-19	187.0	55%	1,907	21.09	347
CRM 2: Wood/vinyl windows	0.0	55%	639	0.00	116
End Use: Space Cooling					
Base case	0.0	100%	0	0.00	0
CRM 3: 12 SEER	530.0	55%	1,951	58.67	355
CRM 4: High efficiency ceiling fans	60.0	55%	2,416	5.34	440
CRM 5: Window heat pump	825.0	55%	3,308	53.64	602
CRM 6: Vegetative cooling	25.0	55%	5,476	0.94	997
CRM 7: Light roof	0.0	55%	217	0.00	39
CRM 8: Evaporative cooling	700.0	55%	7,965	18.90	1,450
End Use: Domestic Hot Water					
Base case	0.0	20%	0	0.00	0
CRM 9: A/C to DHW de-superheater	865.0	11%	827	32.50	151
CRM 10: Hot water saver	250.0	11%	530	20.28	97
CRM 10: DHW heat trap	4.2	11%	253	0.16	46
CRM 10: Solar assisted DHW	727.0	6%	5,499	27.31	1,001
End Use: Lighting					
Base case	0.0	100%	0	0.00	0
CRM 11: Integral compact fluorescents	30.0	55%	2,927	2.20	533
CRM 12: Modular, hard wired CFL	15.0	55%	1,437	2.24	262
CRM 13: T-8 lamps with electric ballasts	72.0	55%	1,910	8.11	348
CRM 14: Ultrasonic occupancy sensors	52.0	55%	745	15.00	136
End Use: Appliances					
Refrigerator	0.0	100%	0	0.00	0
CRM 11: Golden carrot refrigerator	100.0	55%	7,019	3.06	1,278
Freezer	0.0	25%	0	0.00	0
CRM 12: Advanced freezer	172.0	14%	1,506	5.27	274
Dishwasher	0.0	55%	0	0.00	0
CRM 13: Low water and energy use dishwashers	20.0	30%	1,793	0.61	326
Clothes washer	0.0	80%	0	0.00	0
CRM 14: Horizontal axis clothes washer	175.0	44%	8,204	3.67	1,493
Clothes dryer	0.0	55%	0	0.00	0
CRM 15: Heat pump clothes dryer	300.0	30%	7,420	4.78	1,351
Color television	0.0	100%	0	0.00	0
CRM 16: Low powered color television	7.0	55%	622	2.42	113

Sector: Residential
Sub Sector: Multi-Family Retrofit
Fuel: Natural Gas

Measure	Incremental Cost (\$)	Penetration Rate (%)	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
End Use: Space Heating					
Base case	0.0	100%	0	0.00	0
CRM 1: Combined hydronic space heater	1,425.0	55%	6,091	189.91	354
CRM 2: High efficiency gas furnace - pulse combustion	718.0	55%	1,790	325.70	104
CRM 2: Wood/vinyl windows	0.0	55%	20,566	0.00	1,194
CRM 3: Wall insulation R-11 to R-19	230.0	55%	15,745	11.86	914
End Use: Domestic Hot Water					
Base case	0.0	80%	0	0.00	0
CRM 3: Efficient gas water heater	664.0	44%	20,216	21.33	1,174
CRM 4: DHW heat trap	4.2	44%	817	3.34	47
CRM 10: Solar assisted DHW	727.0	44%	20,216	23.35	1,174
End Use: Spa Pool					
Base case spa heating	0.0	8%	0	0.00	0
CRM 5: Solar assisted spa heating	1,200.0	4%	10,677	7.30	620
Base case pool heating	0.0	8%	0	0.00	0
CRM 5: Solar assisted pool heating	1,200.0	4%	10,677	7.30	620

Sector: Commercial
Sub Sector: Small Office
Fuel: Electric

Measure	Incremental Cost (\$)	Penetration Rate (%)	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
End Use: Space Cooling					
Base case	0	100%	0	0.00	0
CRM 1: Economizer maintenance	16	55%	4,718	0.00	859
CRM 2: Clean condenser coils	160	55%	1,730	0.11	315
CRM 3: High efficiency DX AC - COP 3.2	1,223	55%	663	2.18	121
CRM 4: New glazing high performance	3,968	55%	4,817	0.97	877
CRM 5: Time clocks	960	55%	6,274	0.18	1,142
CRM 6: Light colored roof	0	55%	335	0.00	61
CRM 7: Deadband thermostat	94	55%	4,848	0.02	882
End Use: Lighting					
Base case	0	100%	0	0.00	0
CRM 8: Indoor lighting medium load	4,270	55%	4,718	1.07	859
CRM 9: Occupancy sensor pack - 200	463	55%	3,236	0.17	589
End Use: Office Equipment					
Base case electricity consumption	0	100%	0	0.00	0
CRM 10: High efficiency office copiers	75	55%	477	0.21	87
Base case computers	0	100%	0	0.00	0
CRM 11: Energy star rated computers	0	95%	5,467	0.00	995

Sector: Commercial
Sub Sector: Large Office
Fuel: Electric

Measure	Incremental Cost (\$)	Penetration Rate (%)	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
End Use: Space Cooling					
Base case	0	100%	0	0.00	0
CRM 1: High efficiency centrifugal chiller	2,100	55%	808	0.41	147
CRM 2: VSD centrifugal chiller	12,000	55%	6,099	0.31	1,110
CRM 3: Chiller strainer cycle	59	55%	5,740	0.00	1,045
CRM 4: Economizer maintenance	16	55%	1,534	0.00	279
CRM 5: Cooling tower propeller fans	123	55%	254	0.08	46
CRM 6: Oversize coils	1,000	55%	30	5.33	5
End Use: Lighting					
Base case	0	100%	0	0.00	0
CRM 7: Indoor lighting medium load	24,400	55%	4,041	0.96	1,125
CRM 8: Occupancy sensor pack - 1000	2,625	55%	4,049	0.10	1,127
End Use: Office Equipment					
Base case electricity consumption	0	100%	0	0.00	0
CRM 9: High efficiency office copiers	417	55%	3,966	0.02	722
Base case computers	0	100%	0	0.00	0
CRM 10: Energy star rated computers	0	95%	6,466	0.00	1,177

Sector: Commercial

Sub Sector: Retail

Fuel: Electric

Measure	Incremental Cost (\$)	Penetration Rate (%)	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
End Use: Space Cooling					
Base case	0	100%	0	0.00	0
CRM 2: Economizer maintenance	16	55%	1,935	0.01	352
CRM 3: Clean condenser coils	160	55%	1,264	0.16	230
CRM 4: High efficiency DX AC - COP 3.2	1,233	55%	489	3.13	89
CRM 5: New glazing high performance	2,480	55%	352	8.74	64
CRM 6: Economizer installed - packaged	1,592	55%	1,459	1.35	266
CRM 7: Light colored roof	0	55%	456	0.00	83
CRM 8: Time clocks	96	55%	3,249	0.04	591
CRM 9: Deadband thermostat	151	55%	2,909	0.06	529
CRM 10: Shade screens	1,710	55%	448	4.74	81
CRM 11: Reducing over-ventilation	495	55%	203	3.03	37
End Use: Lighting					
Base case	0	100%	0	0.00	0
CRM 12: Indoor lighting medium load	5,338	55%	6,924	0.96	1,260

Sector: Industrial
 Sub Sector: N/A
 Fuel: Electric

Measure	Incremental Cost (\$)	Penetration Rate (%)	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
End Use: Lighting					
Base case	0	100%	0	0.00	0
CRM 1: Lighting load medium reduction	24,400	55%	6,209	2.83	1,130

Sector: Industrial
 Sub Sector: N/A
 Fuel: Electric

Measure	Incremental Cost (\$)	Penetration Rate (%)	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
End Use: Motors					
CRM 1: Motor systems improvements	40,000	80%	182,779	2.00	33,271

Sector: Municipal
Sub Sector: Transportation
Fuel: Transportation Fuels

Measure	Implementation Cost	Penetration Percentage	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
Base case	0	100.0%	0.0	0	0
CRM 1: Convert to CNG	273	0.5%	1.0	20	57
CRM 2: Convert to electric vehicle	485	0.5%	12.0	364	513
CRM 3: Convert to M85 vehicles	94	0.5%	0.5	16	20
CRM 4: Buy CNG vehicles	0	20.0%	47.0	0	4
CRM 5: Buy electric vehicles	0	30.0%	691.0	0	64
CRM 6: Buy M85 vehicles	0	20.0%	19.0	0	1
CRM 7: Fuel efficient gasoline and diesel vehicle	0	5.0%	148.0	0	11

Source: CEC Transportation Plan; SDREP - TCM.WB1

Sector: Municipal
Sub Sector: Buildings
Fuel: Electric

Measure	Incremental Cost (\$)	Penetration Rate (%)	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
End Use: Space Cooling					
Base case	0	100%	0	0.00	0
CRM 1: High efficiency centrifugal chiller	2,100	30%	504	0.37	92
CRM 2: VSD centrifugal chiller	12,000	30%	3,801	0.28	692
CRM 3: Chiller strainer cycle	59	30%	3,578	0.00	651
CRM 4: Economizer maintenance	16	30%	977	0.00	178
CRM 5: Cooling tower propeller fans	123	30%	160	0.01	29
CRM 6: Oversize coils	1,000	30%	188	0.47	34
End Use: Lighting					
Base case	0	100%	0	0.00	0
CRM 7: Indoor lighting medium load	24,400	30%	2,586	0.83	471
CRM 8: Occupancy sensor pack - 1000	2,625	30%	2,526	0.09	460

Sector: Municipal
Sub Sector: Traffic Lighting
Fuel: Electric

Measure	Incremental Cost (\$)	Penetration Rate (%)	Energy Savings (2010 MMBtu)	Simple Payback (Years)	CO ₂ Savings/Yr (2010 Tons)
End Use: N/A					
Base case	0	100%	0	N/A	0
CRM 1: LED traffic lights	200	100%	357	2.53	65

